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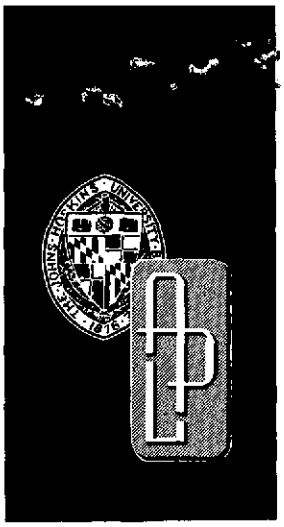
APRIL 1974



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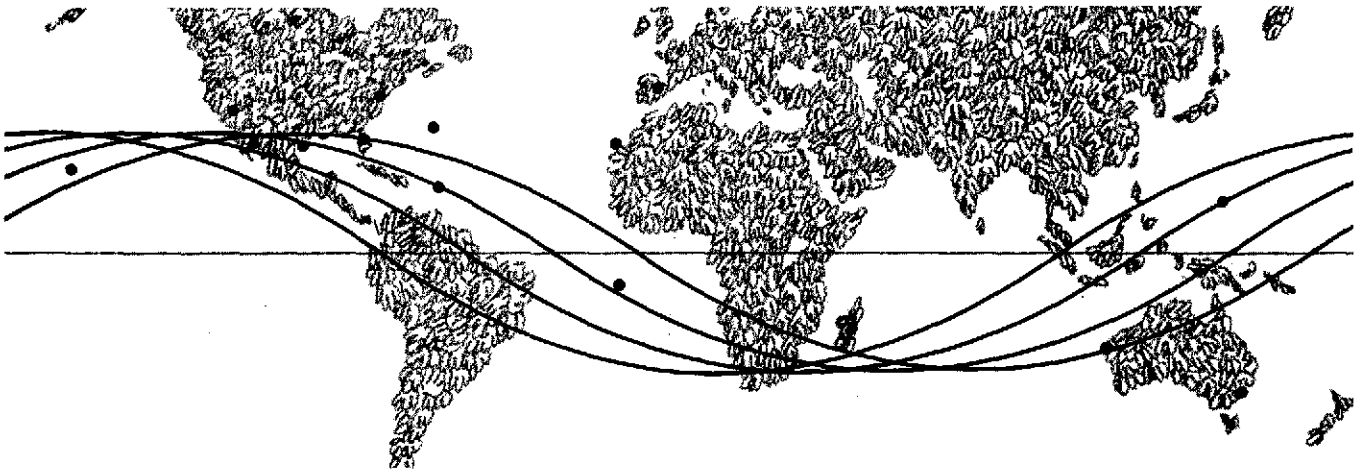
Special Report

SPACEFLIGHT TRACKING AND DATA NETWORK OPERATIONAL RELIABILITY ASSESSMENT FOR SKYLAB

SPACE COMMUNICATIONS GROUP



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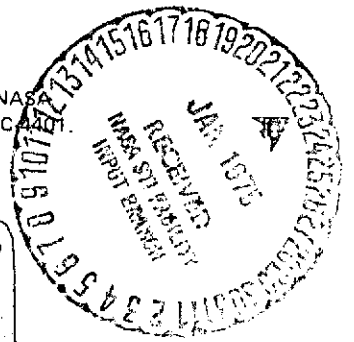
The work reported in this document was funded by NASA under NDPR S-70130G to Navy Contract N00017-72-C-4401.



CSC-1-395
APRIL 1974

Special Report

SPACEFLIGHT TRACKING AND DATA NETWORK OPERATIONAL RELIABILITY ASSESSMENT FOR SKYLAB

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SILVER SPRING, MARYLAND

I. INTRODUCTION

Data on the spaceflight communications equipment status during the SKYLAB (SL) Mission have been subjected to an operational reliability assessment and the results are reported herein. These data were collected during the period beginning with the issuance of ISI-1 for the SKYLAB Mission and the return to earth of the Command Service Module (CSM) used in support of SL-4. The format of this report is similar to the earlier Apollo Mission reports.

Reliability models have been revised to reflect pertinent equipment changes accomplished prior to the beginning of the SKYLAB Missions. Since the same changes were not accomplished at all stations, appropriate adjustments were made to fit the data to the models. For this assessment the availabilities are based on those failure events resulting in the stations inability to support a function or functions and the MTBF's are based on all events including "can support" and "cannot support".

The Network Operations Control Center and Station Interface Procedures[1] requests the message format to include the NCG number of the mission or test affected and a brief statement of the problem. The Applied Physics Laboratory (APL) personnel have used this information to determine whether or not the functional capabilities of the station were impaired. Occasionally the message would contain the statement "can support ...." and this position was accepted in lieu of our own judgement. Each event in the file is coded accordingly as either "cannot support" or "can support". It should be stressed that this support qualification applied only to the functional capability of the station. It does not apply to the equipment responsible for the event which invariably is in a failed state; i.e., it either cannot support or can support only partially the equipment configuration requirements. It is, of course, possible to have "failed" equipment and no impact on station functional capabilities because of the redundancy at the system level.

Data for this report have been received from eleven land-based stations and one ship (VANGUARD). UHF and VHF systems have been included in the models since they provided full time support of SKYLAB Mission.

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1 Network Operations Control Center and Station Interface Procedures, Volume 1, Section 13.2, Change 2 to Revision 2, November 1972.

II. DESCRIPTION OF THE DATA BASE

The data used for the analysis of this SKYLAB Report were collected during the periods of mission status as listed in Table 1 and graphically shown in Figure 1 - Mission Profile for SKYLAB.

The Instrumentation Support Instruction (ISI) transmitted to all supporting sites tells the sites when the phase "ON MISSION STATUS" is to begin. It is this "Preflight Begin" time which is quoted in Table 1. The return to earth of the third Command Service Module (CSM) terminates the SKYLAB reporting period.

Data were collected at eleven land-based sites and one ship (VANGUARD) stationed dockside in Argentina. Table 2 presents the stations in support and the systems at each site. C-band, GRARR and SCE failure data are not included in the reliability models or in this report because of the limited distribution of these equipments in the Network. The notes in Table 2 indicate other minimal support required for SKYLAB. Data or the assessment of these minimal support requirements is not a part of this report. It should be noted here that as in the previous Apollo Operational Reliability Assessment Reports the emphasis is on the homogeneous configuration of the stations because of the complex modeling and computations required for a hard analysis of the unique equipment inventories at each site. The raw data consists of red, yellow and green Equipment Status Reports (ESR) which are submitted to the Network Operations Manager (NOM) in accordance with Section 13.2 of the STDN Operations Center and Station Interface Procedures.[2] Arrangements similar to those for the Apollo Missions were made at the Goddard Space Flight Center (GSFC) to permit APL access to all the pertinent written (TTY) STDN status messages during the SKYLAB Mission.

Table 3 is a summary of the observation times and events for the SKYLAB Mission phases. Table 4 shows the Apollo and SKYLAB cumulative observation times and the event rate per hour. As shown in Table 4 the increase in observation time for the SKYLAB Mission over that of the Apollo cumulative time is fifteen percent. The fifteen percent increase in observation time for the SKYLAB Mission is used in calculating the expected number of failures for SKYLAB. Figures 2A, 2B, and 2C (Distribution of Failures) compares the expected and observed number of failure events for the Unified S-Band (USB) and Remote Site Data Processing (RSDP) equipments. Prior to SKYLAB, UHF and VHF equipments were not part of Network assessment due to the limited support these systems were required to provide. Table 5 lists the observed failures for the UHF and VHF equipments during the SKYLAB Mission. Figure 3 is a comparison of the expected and observed number of failures for those eight subsystems which during the Apollo Mission experienced the most failures. This comparison results in a failure rate for SKYLAB at about fifty-five percent for that of the Apollo period.

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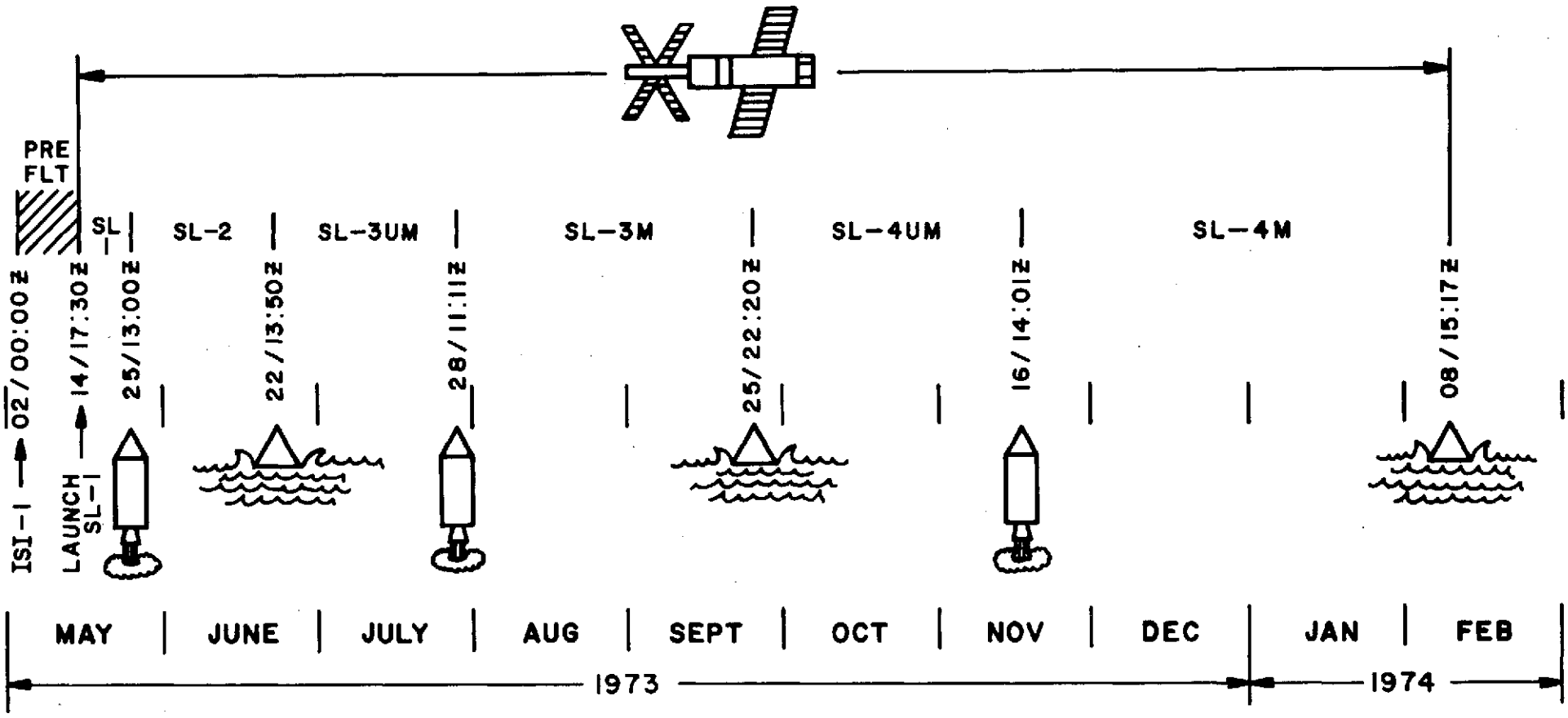
2 STDN No. 502.16, loc. cit.



MISSION PROFILE FOR SKYLAB
FIGURE 1

TABLE 1

MISSION DESCRIPTION FOR

SKYLAB

MISSION PHASE	BEGIN	END	DURATION
PREFLIGHT	5/2/00:00Z	5/14/17:30Z	305.5
SKYLAB-1 (UNMANNED)	5/14/17:30Z	5/25/13:00Z	259.5
SKYLAB-2 (MANNED)	5/25/13:00Z	6/22/13:50Z	672.8
SKYLAB-3 (UNMANNED)	6/22/13:50Z	7/28/11:11Z	861.2
SKYLAB-3 (MANNED)	7/28/11:11Z	9/25/22:20Z	1427.2
SKYLAB-4 (UNMANNED)	9/25/22:20Z	11/16/14:01Z	1239.7
SKYLAB-4 (MANNED)	11/16/14:01Z	02/08/15:17Z *	2017.3

*Only date in 1974

TABLE 2

MISSION SUPPORT

Station	Systems			
	C-Band	USB	VHF	UHF
ACN		X	X	X
BDA	X	X	X	X
CRO	X	X	X	X
CYI		X	X	X
GDS		X	X	X
GWM		X	X	X
HAW		X	X	X
HSK		X	X	X
MAD		X	X	X
MIL		X	X	X
TEX		X	X	X
VAN		X	X	X

Notes: (1) CNV or any other ETR radar in the Cape area is required to track Jimsphere balloon ascents.

(2) St. Johns, Newfoundland, will provide support for launch and early orbit phases for SL-1/2. A/G voice will be provided for the launch and early orbit phases of SL-2,3 and 4.

(3) BDA will provide C-band tracking support during launch only.

(4) Preliminary requirements for range safety at Wallops Island.

(5) Mission support indicated in Notes is not included in this reliability assessment.

TABLE 3

SUMMARY OF OBSERVATION TIMES AND

EVENTS FOR THE SKYLAB MISSION PHASES

MISSION PHASE	A NUMBER OF SITES	B DURATION IN HOURS	C SITE HOURS A x B	D NUMBER OF CANNOT SUPPORT EVENTS	E NUMBER OF CAN SUPPORT EVENTS	F AVERAGE NUMBER OF EVENTS/SITE (D+E)/A	G AVERAGE EVENT RATE/HOUR (D+E)/C
PREFLIGHT	12	305.5	3666.0	27	38	5.4	.018
SKYLAB-1 (UNMANNED)	12	259.5	3114.0	29	51	6.7	.026
SKYLAB-2 (MANNED)	12	672.8	8073.6	55	122	14.8	.022
SKYLAB-3 (UNMANNED)	12	861.2	10334.4	61	106	13.9	.016
SKYLAB-3 (MANNED)	12	1427.2	17126.4	155	209	30.3	.021
SKYLAB-4 (UNMANNED)	12	1239.7	14876.4	136	99	19.6	.016
SKYLAB-4 (MANNED)	12	2017.3	24207.6	224	184	34.0	.017

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TABLE 4

SUMMARY OF OBSERVATION TIMES AND AVERAGE
EVENT RATES PER HOUR FOR SKYLAB AND
APOLLO MISSION CUMULATIVE

MISSION	A TOTAL OBSERVATION TIME	B TOTAL NUMBER OF FAILURES	AVERAGE EVENT RATE PER HOUR B / A
SKYLAB CUMULATIVE*	81348.4	1496	.018
APOLLO CUMULATIVE	71090.5	1880	.026

*SKYLAB Cumulative Time is 115% of the Apollo Cumulative Time.

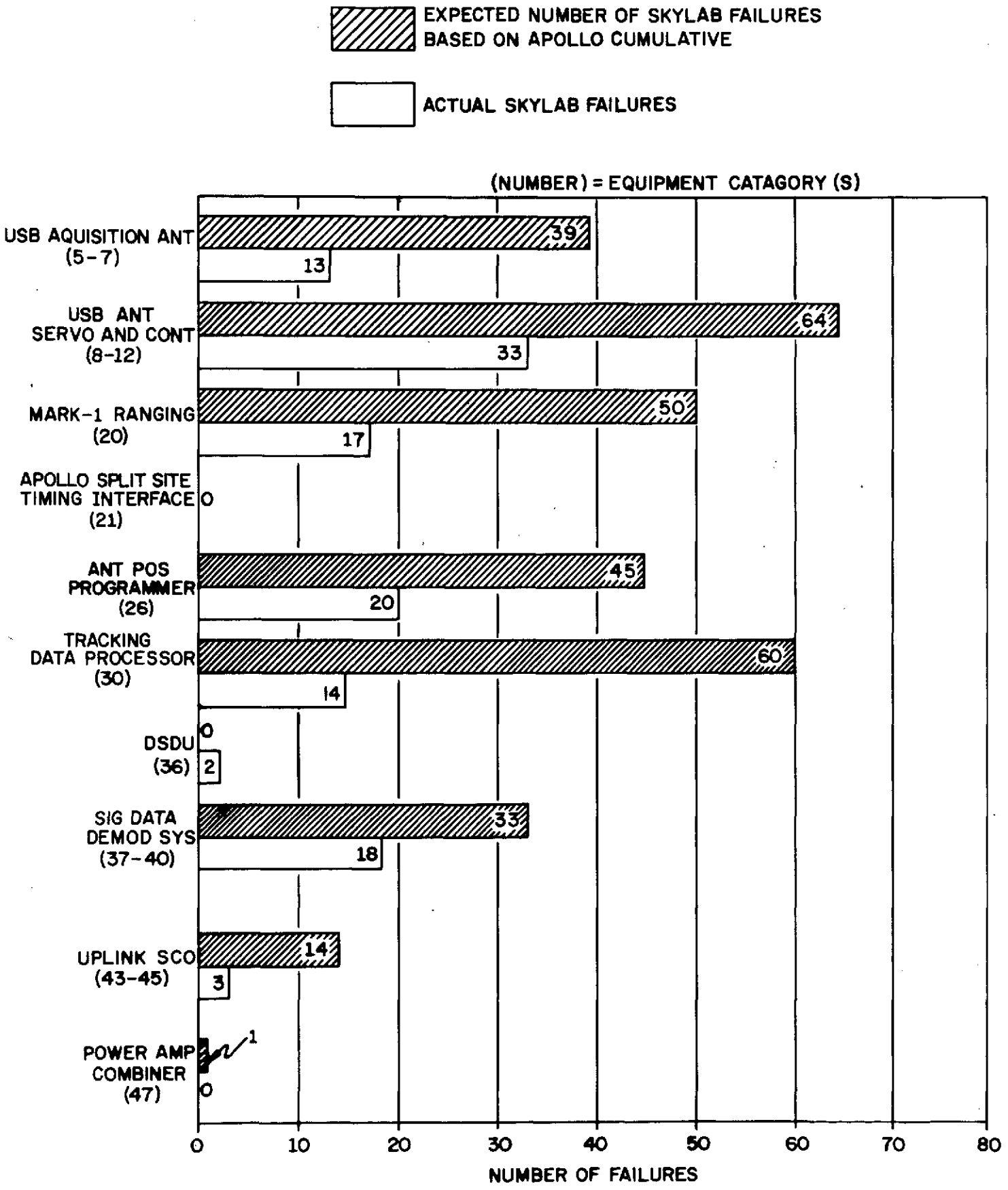


FIGURE: **2A**
DISTRIBUTION OF FAILURES

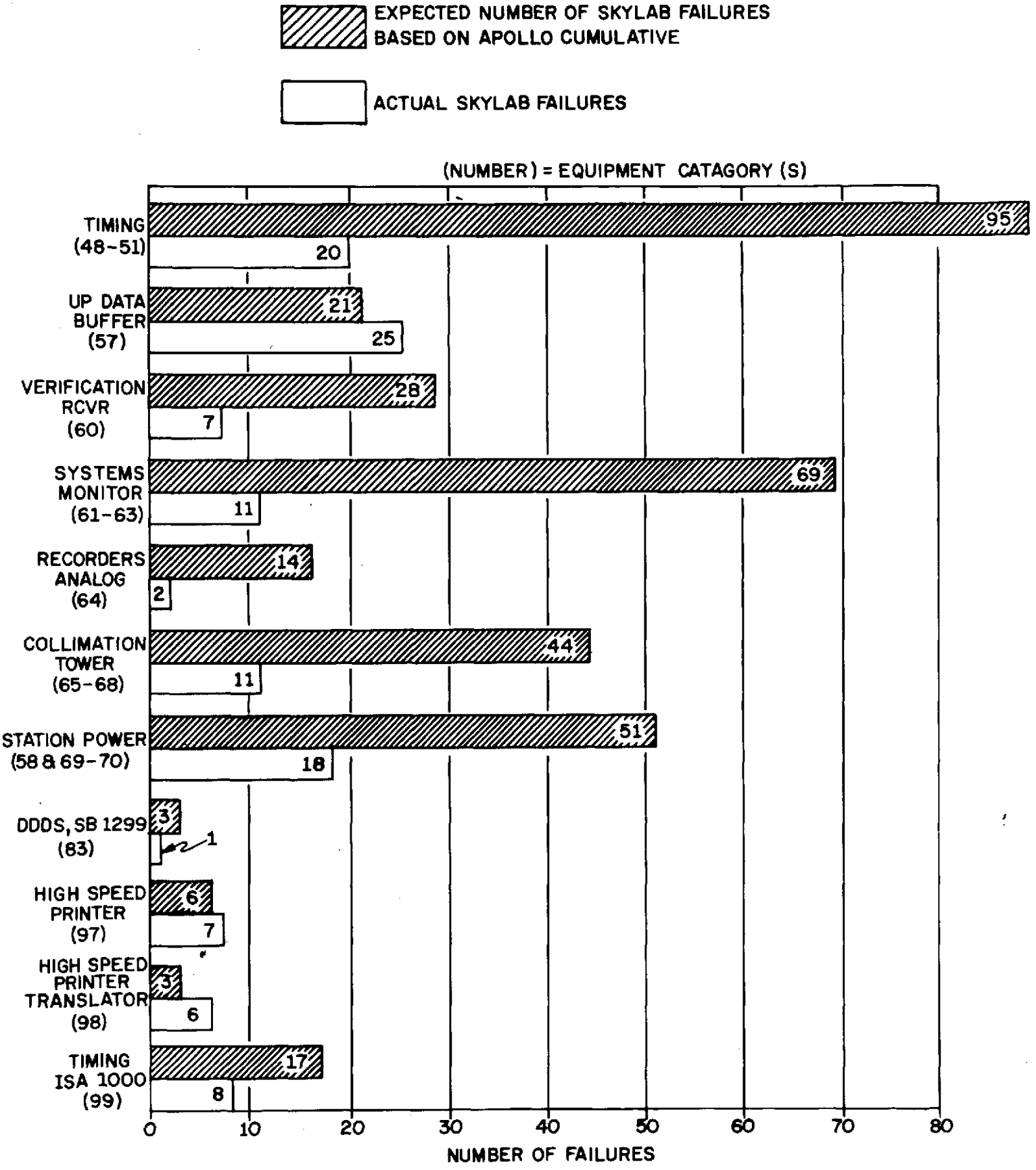


FIGURE: 2B
DISTRIBUTION OF FAILURES

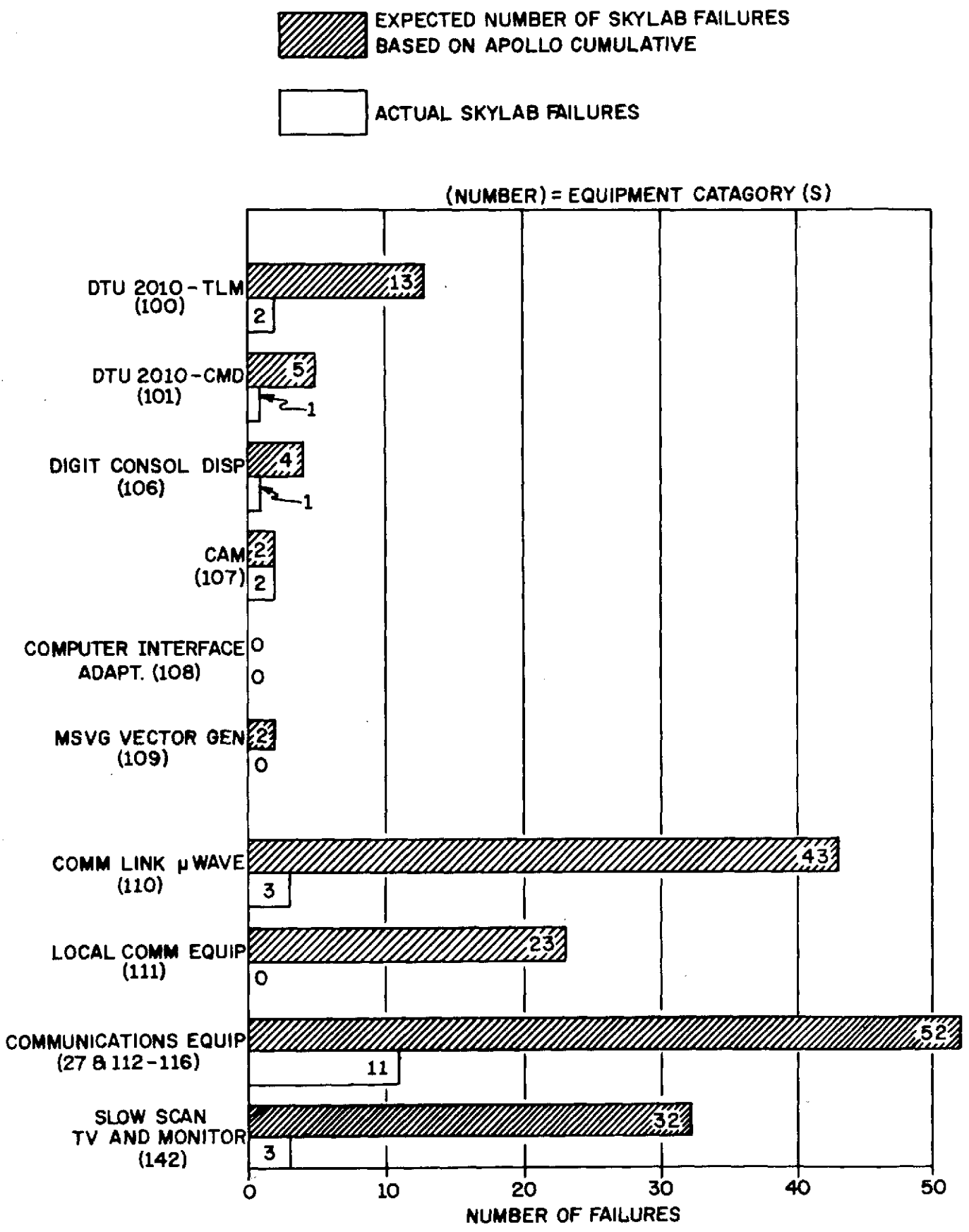


FIGURE: 2C
DISTRIBUTION OF FAILURES

TABLE 5

VHF AND UHF SUBSYSTEM FAILURES

VHF SUBSYSTEM

Catalog No.	Subsystem	No. of Failures
117	ACQ AID; ANT	76
118	ACQ AID; RCVR	7
119	ACQ AID; SERVO	19
120	ACQ AID: Position Indicators and Servo Controls	4
121	ACQ AID; I/F ACQ. BUS	--
122	ACQ BUS	4
123	VHF TLM RCVRS	119
124	VHF VOICE XMTR/RCVR	46

UHF SUBSYSTEM

Catalog No.	Subsystem	No. of Failures
77	UHF (GENERAL)	9
125	UHF CMD ANT	25
126	UHF SERVO	15
127	UHF CMD XMTR (FRW-2A)	40
128	UHF CMD P. A. (240 D-2)	37
129	VERIF. RCVR (AN/FRW-2A)	9
130	DIGITAL CMD SYS (DCS)	6

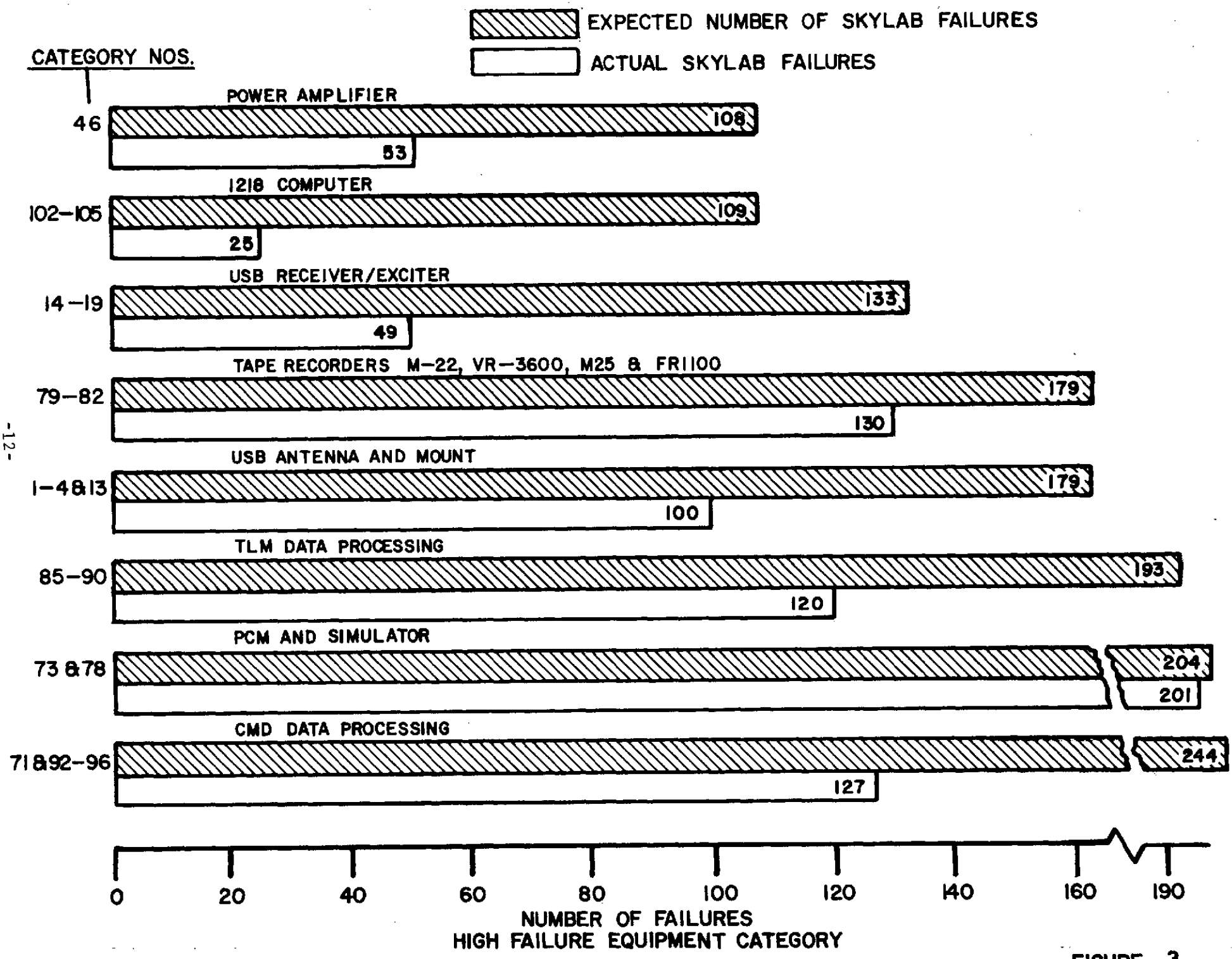

EXPECTED NUMBER OF SKYLAB FAILURES
ACTUAL SKYLAB FAILURES
CATEGORY NOS.
POWER AMPLIFIER
46
108
53
1218 COMPUTER
102–105
109
25
USB RECEIVER/EXCITER
14–19
135
49
TAPE RECORDERS M–22, VR–3600, M25 & FR1100
79–82
179
130
USB ANTENNA AND MOUNT
1–4&13
179
100
TLM DATA PROCESSING
85–90
193
120
PCM AND SIMULATOR
73 &78
204
201
CMD DATA PROCESSING
71&92–96
244
127
0
20
40
60
80
100
120
140
160
190
NUMBER OF FAILURES
HIGH FAILURE EQUIPMENT CATEGORY

FIGURE 3

III. PART 1: DESCRIPTION OF STATION ANALYSIS

The approach taken herein to assess the overall operational reliability of the STDN is to determine a measure of the ability of the network to accomplish the functions pertinent to the assigned mission. There are two distinct parts to the analysis. The first part deals entirely with the computation of statistics for the individual stations or group of stations. The second uses these statistics to assess the network operational reliability for pertinent mission phases and compares these results to the predicted performance. Data to support the first part are provided by the individual sites in terms of their status, i.e., red, yellow or green. Red indicates a system is not operational and is unable to support any anticipated requirements; yellow indicates a system is unable to support as documented; and green indicates the equipment is operational in its normal documented configuration. Red, yellow and green status for AS-512 are defined in the Network Operations Center and Station Interface Procedures.* Red status events for this first SKYLAB Report were qualified by the Applied Physics Laboratory as "can support" (CS) and "cannot support" (CNS) based on the content of the status message; yellow status events were qualified as red "can support". Qualification of the red or yellow status as "can support" is interpreted to mean that the performance is adjudged satisfactory even though overall performance may be impaired and/or substitute parts (e.g., bench power supplies) are being used. Recognition of these two levels (CS and CNS) is given in the analysis (to be discussed subsequently) so that the estimated functional MTBF reflects all of the pertinent failures, whereas the availability estimated is based on the critical "CNS" events.

The list of equipment categories and equipment category codes is presented in Appendix I: "Equipment Subsystem Categories for Reliability data (73-1)." This list has been revised relative to the corresponding list (72-1B) published in the previous report. Revisions were made to add new categories as required to satisfy the new equipments. It will also be noted that Appendix I has a hierarchical structure which relates major equipment categories to (sub) categories where applicable. Some of these major equipment categories have been assigned category codes and some have not. If the major equipment category has no code, the total number of events assigned to that category is the sum of the events assigned to the (sub) categories. If the major equipment category has a code assigned, there may be events assigned to the major equipment category code which must be included with the sum of the (sub) categories to get the total number of events in the major category.

Support capabilities are measured in terms of the mission support functions assigned to the STDN site. A list of the mission support functions which have been defined for this analysis is presented in Appendix II. The functions are divided into hierarchical groups labeled with Roman numerals and identified as major functions. Each group is composed of subfunctions which are labeled with an alphabetic character.

* STDN No. 502.16, loc. cit.

Each major function is the sum of all the pertinent subfunctions, i.e., whenever any one of the subfunctions is red or yellow, the major function is either red or yellow. It should be noted here that the major functions are not independent, i.e., some equipment categories are presented in two or more major functions; consequently, the four major functions should not be combined to represent a station. This restriction will become more evident with the subsequent presentation of the reliability models.

Each of the mission support functions assessed by the computer program is based upon a reliability model constructed from the equipment subsystem categories which are used in various combinations for estimating the MTBF and availability of each of the twenty-four functions. These thirty-one basic functional reliability models are defined in Appendix III by showing the specific equipment categories which are used in each model. The number of equipments modeled in each category is based upon the "MSFN Equipment Allocations Handbook."[3] Engineering Instructions (EIs) that are specified as applicable for the mission are reviewed to determine whether or not they are significantly different from the Handbook. When two or more equipments of the same type are present in the system configuration, it cannot be assumed that they are redundant. Redundancy is present only when one or more unassigned, or spare standby equipments, is indicated by the station configuration or by the "Mission Supplements to the NOP."

Not all of the equipment categories contained in Appendix I are used in the models, because some red or yellow status events involve equipment (such as test equipment) which has no direct impact on the functional reliability. Since these events do contribute to the continuity of the data and may aid the interpretation of other events, they are included in the data base. The reliability models reflect the designed equipment redundancy (as opposed to jury-rigged adaptations) except for the primary power sources and the data modems. In both of these latter instances, the variations in quantities and configurations of the equipment at each station preclude the use of an average model. All red or yellow status events in these categories are reviewed manually and downtime is accumulated only when the function cannot be supported. In most cases, for example, a "cannot support" primary power generator will not result in downtime for any of the functions since the remaining generators can carry the load.

As stated in the opening paragraph, the analysis is "function" oriented. Two major statistics are computed as measures of the functions defined in Appendix II. These are (1) availability (A) and (2) mean-time-between-failures (MTBF). These statistics should not be confused with numbers having similar labels which are frequently computed for the equipment or hardware. The APL computer program has been designed to relate the equipment status to the function-status via the reliability models and data interpretation described above. Consequently, a function availability of 0.9 can be taken to mean that ninety percent of the time the station

3 NASA, MSFN Equipment Allocations Handbook (Parts 1 and 2), MSG-403, Revised 1 April 1969.

(or stations) observed were capable of performing the function. Similarly, an MTBF of one-hundred hours means that on the average the station (or stations) being observed experience an interruption of the function every one-hundred equipment hours. Equipment or hardware availability and MTBF may, in fact, usually will, be significantly different from the corresponding function values, not only because several equipment may have to interact to achieve the desired functional capabilities, but also because redundant combinations of equipment may permit accomplishment of the function even when some equipment failures are present.

Selection of the data and computational schemes for the "function" statistics is based on fulfilling two principal objectives: (1) to obtain the most realistic measure of actual network performance and (2) to measure the level of maintenance activity required to achieve this performance. Since the network stations have redundant capabilities for many of the functions, as well as very resourceful operating personnel, it is conceivable that a high level of availability may be observed even though many of the layers of redundancy are in a failed state. In keeping with these objectives, the availability is calculated using only the downtime for the "cannot support" status events. On the other hand, all red and yellow status events are used in the computation of the MTBF to provide the desired measure of corrective maintenance activity. This is accomplished by assigning an arbitrary one minute downtime to all "can support" events, thereby reducing the contribution of downtime from this source to negligible proportions. Note once again that the availability and the MTBF statistics apply to functionally related equipment groups and not to specific items of equipment.

Using the data and ground rules cited above, the MSFN Support Function Program computes the availability and MTBF for specified time intervals. Upper and lower ninety-five percent confidence limits are also computed for each site. Since failure and restore time experience may probably be different for the Preflight, the unmanned spacecraft and the manned spacecraft portions of the mission separate computations are made for each of these periods.

The MTBF is computed by dividing the operating time (as measured in mission-support-function hours) by the number of failures experienced at a function level. To estimate operating time, it is assumed that all equipment is operating for the duration of the mission unless it is explicitly reported down (status red) or not in use. For the site or sites supporting the function, the operating time is obtained by deducting the total downtime for the site or sites from the sum of the mission times accumulated at each of the sites supporting the function.

Occasionally no failures will be encountered during either or both of the mission phases (preflight and flight) and no estimate of MTBF can be computed. It is possible to estimate the lower ninety-five percent confidence limit based on the observed duration of satisfactory operation, and in the absence of an MTBF for use in subsequent computations, the

lower ninety-five percent confidence limit has been substituted. This substitution is justified on the basis of being a worst case MTBF even though it may appear to be inconsistent with an estimate based on cumulative data. The broader based cumulative estimate is the better, i.e., nearer to the true value, if one can be assured that there has been no change in the population being sampled. But discovery of a change is the purpose of the analysis; consequently, the best estimate that can be made using only the data pertinent to the mission is preferred.

Total downtime is the sum of the downtimes assigned to the function being assessed at the particular set of sites being assessed. The downtime assigned to a function at the site level may or may not be the arithmetic sum of the downtimes experienced at that site. It will not be if two or more failures exist simultaneously for a given function at a given site so that the downtimes overlap. The overlap for each failure after the first is deducted from the total.

Likewise, the total number of failures is the sum of the failures assigned to the function being assessed at the particular set of sites being assessed. The number of failures assigned to the function at the site level, however, may or may not be equal to the number of "status red" reports on that function. The number can be less for two reasons: (1) when the red times assigned to a given function overlap, only one failure is assessed for two or more red times; and (2) if the design provides for redundant channels, a failure is assigned only when all channels are down simultaneously.

The upper and lower ninety-five percent confidence limits for the MTBF are computed on the basis that the MTBFs have a chi-squared distribution about the sample mean.

Availability is estimated as the ratio of operate time to total mission time, both of which are measured in terms of "function hours." Operate time is identical to the operate time used to compute the MTBF, and total mission time is the sum of the mission times accumulated at the sites supporting the function.

III. PART 2: DESCRIPTION OF NETWORK ANALYSIS

The operational range of the SKYLAB Mission is a near earth orbital trajectory requiring full time support of the VHF, UHF, S-band and C-band systems. This report includes the analysis of the VHF, UHF, and S-band systems in support of SKYLAB as they are located on all stations while the C-band system is found at only two sites as shown in Table 2.

Previous Apollo operational reliability assessments had four models to reflect network operations: (1) from launch until translunar injection (TLI), (2) following TLI, (3) at lunar distance and (4) landing (the last four hours of flight). The SKYLAB earth orbital flight limits its reliability assessment to model one of these models from the previous Apollo reports.

STDN coverage is limited to varying degrees by the earth interrupting the line-of-sight communication between the stations and the spacecraft.

The network analysis will be a calculation of the average station MTBF and availability based on a twenty-four hour support requirement to maintain the equipments on stations in a "green" (can support) status.

IV. RESULTS OF ANALYSIS

The data described in Section II were analyzed as described in Section III and the results of the analysis are presented in the following paragraphs. The computer program was used to obtain the major function and subfunction MTBF and availability for each site and the combined MTBF and availability for the average station.

Summary graphs of the availability and MTBF for the five major functions (I - Tracking; II - Voice Communications; III - Monitoring; IV - Uplinking, and V - Television) are presented by Figure 4 through Figure 13. Numerical data used to plot the graphs are presented by Table 6 and Table 7. The values plotted and tabulated are for the "average station", i.e., the average of all the stations participating in the network for the indicated mission phase. Averaging is accomplished in accordance with the procedures described in Section III. MTBF and availability cumulative values for the Apollo series of reports is also shown in the Tables 6 and 7. These values are also shown graphically in Figure 4 through Figure 13 to provide an indication of comparative performance.

SKYLAB AVAILABILITY

		FUNCTION I	II	III	IV	V
Preflight	UL	.99795	.99936	.99804	.94020	.99892
	Mean	.98704	.98800	.98762	.87094	.97982
	LL	.92261	.81247	.92587	.74335	.71873
SL-1	UL	.99769	.99966	.99963	.99445	.98938
	Mean	.99315	.99781	.99765	.98716	.93583
	LL	.97986	.98614	.98514	.97054	.69532
SL-2	UL	.98804	.99978	.98725	.96861	.99840
	Mean	.97086	.99935	.97079	.94114	.99321
	LL	.93073	.99806	.93448	.89230	.97157
SL-3UM	UL	.99948	1.00000	.99146	.98514	1.00000
	Mean	.99777	.99998	.97909	.97000	.99998
	LL	.99051	.99954	.94971	.94037	.99954
SL-3M	UL	.98542	.98750	.99098	.98180	.98210
	Mean	.97486	.97675	.97924	.97093	.96110
	LL	.95698	.95717	.95293	.95386	.91756
SL-4UM	UL	.97869	.98524	.97927	.96407	.97813
	Mean	.96445	.97367	.96660	.94662	.95475
	LL	.94127	.95348	.94660	.92137	.90870
SL-4M	UL	.97136	.98988	.98257	.95313	.98992
	Mean	.95847	.98320	.97185	.93461	.98024
	LL	.94014	.97224	.95485	.90946	.96161
SL-UM	UL	.98692	.99175	.98305	.97055	.98379
	Mean	.97976	.98592	.97457	.95961	.96917
	LL	.96883	.97608	.96201	.94483	.94216
SL-M	UL	.97464	.98862	.98215	.95960	.98483
	Mean	.96618	.98360	.97424	.94826	.97573
	LL	.95502	.97644	.96296	.93396	.96136

APOLLO CUM AVAILABILITY

Preflight	UL	.97319	.98832	.97146	.95878	NO DATA
	Mean	.96307	.98145	.96046	.94557	
	LL	.94934	.97065	.94546	.92844	
Flight	UL	.98560	.98928	.98001	.98191	
	Mean	.98026	.98375	.97296	.97581	
	LL	.97299	.97546	.96351	.96773	

TABLE 6

AVAILABILITY DATA FOR GRAPHS
OF MAJOR SUPPORT FUNCTIONS

SKYLAB MTBF

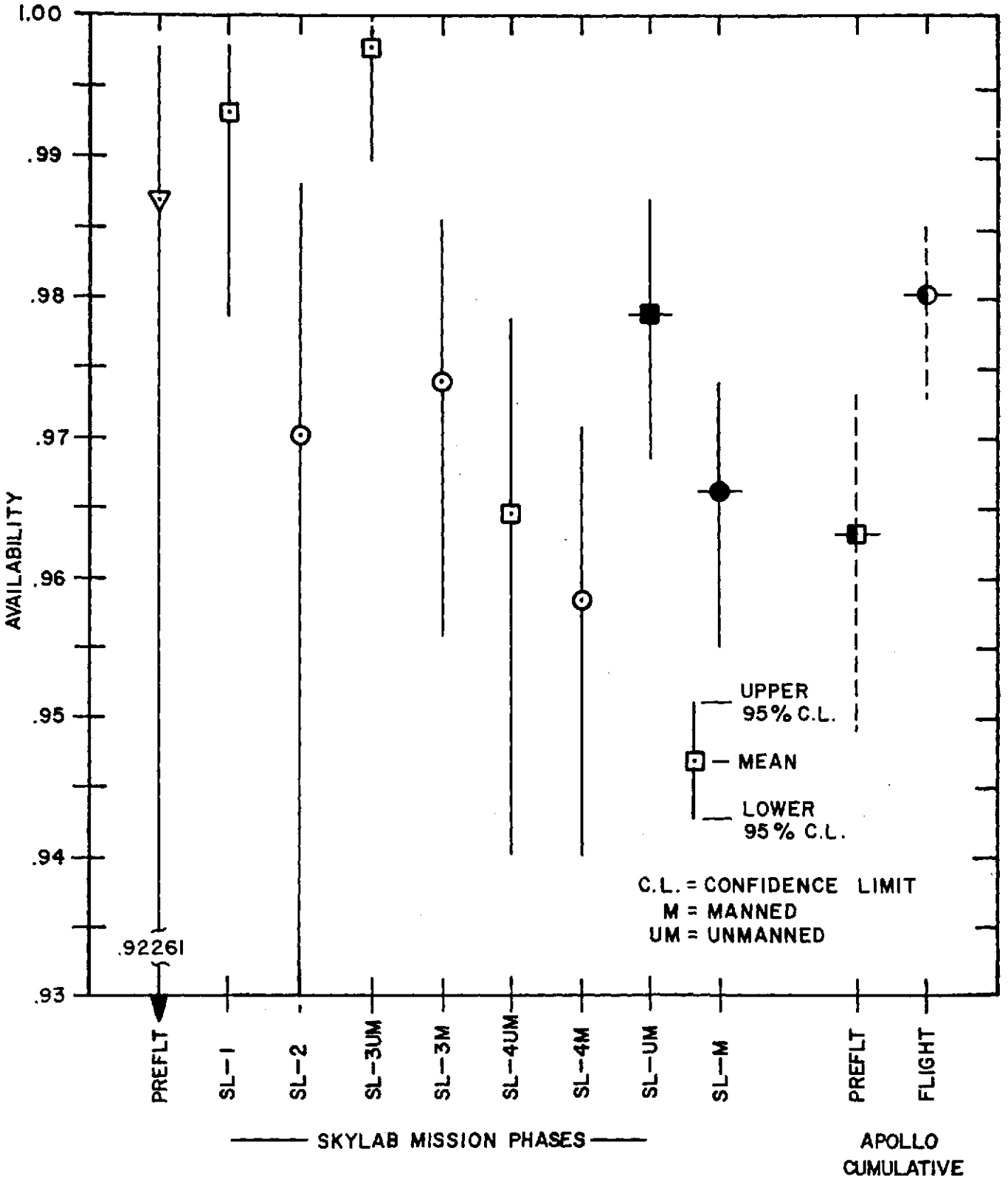
		FUNCTION I	II	III	IV	V
Preflight	UL	468.22	1829.42	271.81	159.53	1374.64
	Mean	276.95	720.79	180.12	113.38	598.66
	LL	185.18	393.72	129.22	85.26	341.67
SL-1	UL	446.64	2273.79	220.76	108.00	1479.25
	Mean	257.71	776.78	147.92	80.88	582.82
	LL	169.85	400.74	106.89	63.14	318.36
SL-2	UL	308.50	872.61	152.38	116.38	1158.15
	Mean	228.02	537.91	122.46	95.84	668.25
	LL	176.31	368.66	100.86	80.49	440.42
SL-3UM	UL	828.96	2596.29	228.51	168.39	3145.89
	Mean	542.78	1291.98	180.70	137.33	1476.55
	LL	386.40	786.11	146.97	114.44	872.77
SL-3M	UL	272.25	509.81	148.71	115.84	515.36
	Mean	222.69	389.01	128.00	101.38	391.89
	LL	186.00	307.92	111.51	89.57	309.40
SL-4UM	UL	415.11	621.74	221.31	160.35	1678.05
	Mean	318.82	452.64	182.01	135.39	1014.50
	LL	253.60	346.21	152.69	116.06	687.18
SL-4M	UL	298.50	597.27	175.33	134.73	723.19
	Mean	249.47	466.67	152.75	119.06	551.82
	LL	212.05	376.07	134.45	106.09	416.80
SL-UM	UL	445.82	829.05	202.91	141.96	1506.95
	Mean	365.16	634.71	176.95	126.42	1055.88
	LL	305.36	503.66	155.87	113.40	786.28
SL-M	UL	265.80	525.86	150.95	117.20	592.31
	Mean	235.88	445.83	137.91	108.10	496.97
	LL	210.95	383.48	126.56	100.07	428.80

APOLLO CUM MTBF

		I	II	III	IV	
Preflight	UL	234.47	459.54	168.44	138.39	NO DATA
	Mean	201.82	374.23	148.23	123.10	
	LL	175.81	311.49	131.59	110.32	
Flight	UL	193.08	448.99	158.37	131.36	
	Mean	165.99	358.08	137.94	115.95	
	LL	144.45	293.17	121.44	103.04	

TABLE 7

MTBF DATA FOR GRAPHS OF MAJOR SUPPORT FUNCTIONS

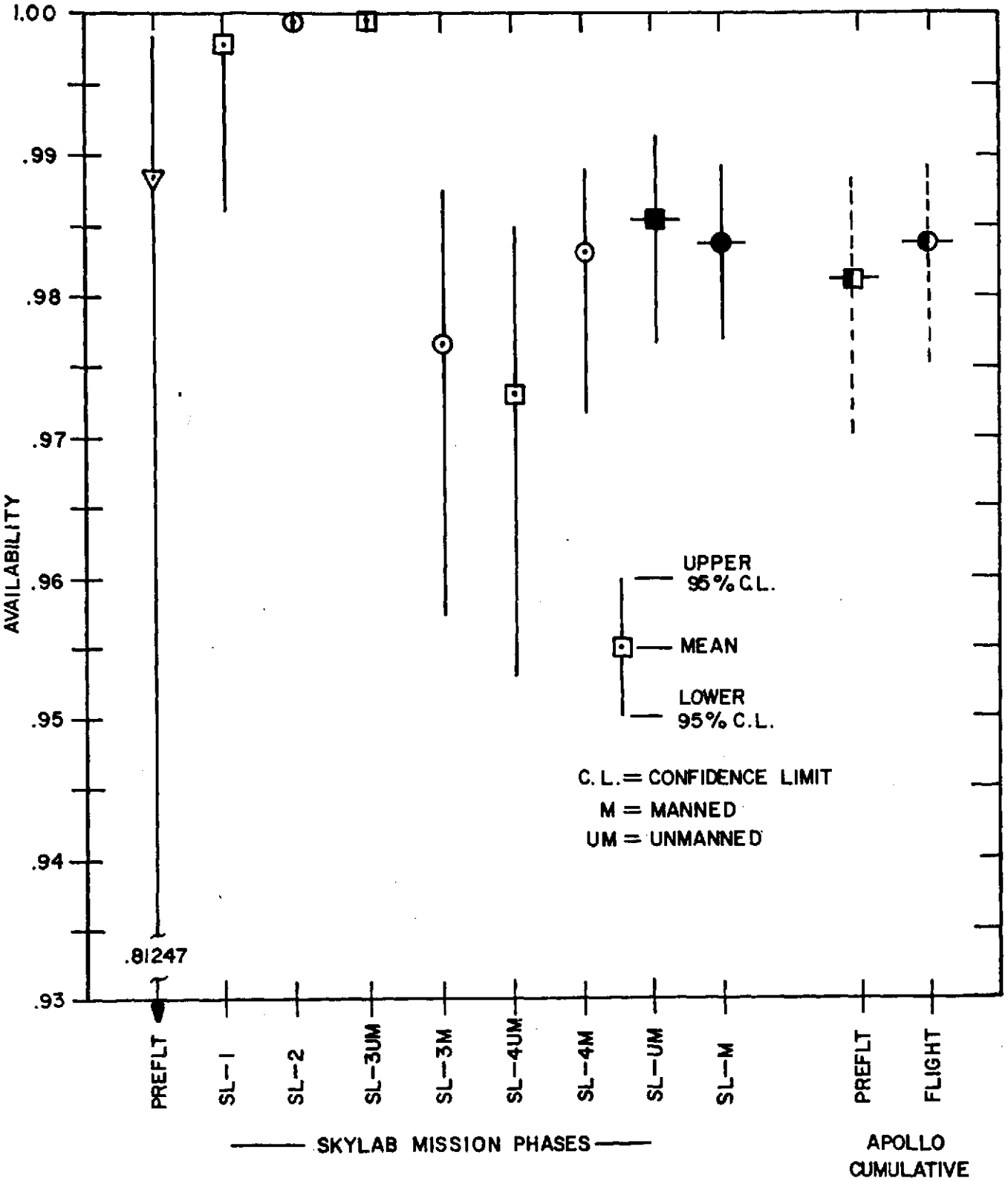


MAJOR SUPPORT FUNCTION I

SPACECRAFT TRACKING

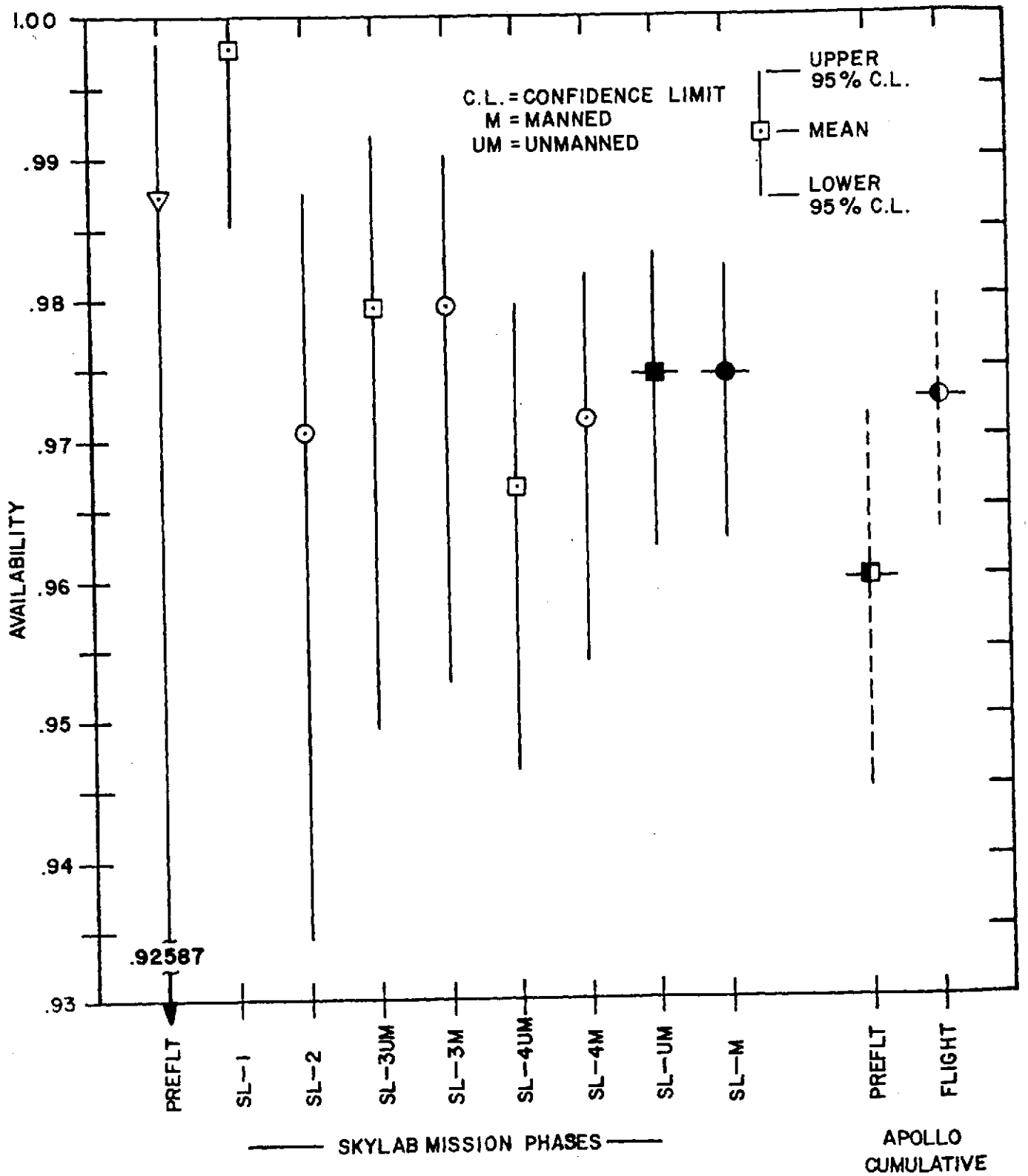
AVAILABILITY FUNCTION I

FIGURE: 4



MAJOR SUPPORT FUNCTION II
SPACECRAFT COMMUNICATIONS — VOICE
AVAILABILITY FUNCTION II

FIGURE: 5

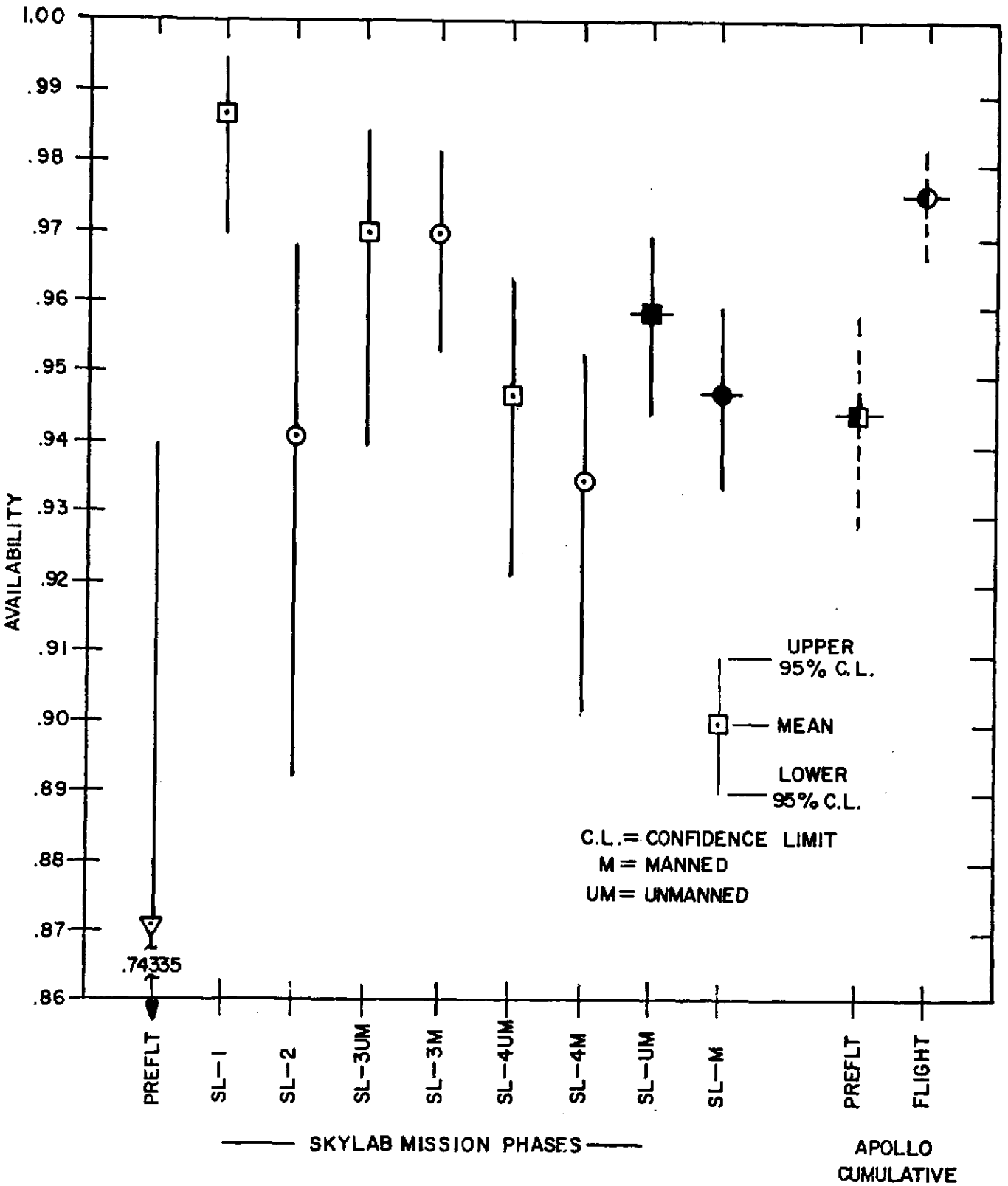


MAJOR SUPPORT FUNCTION III

SPACECRAFT MONITORING

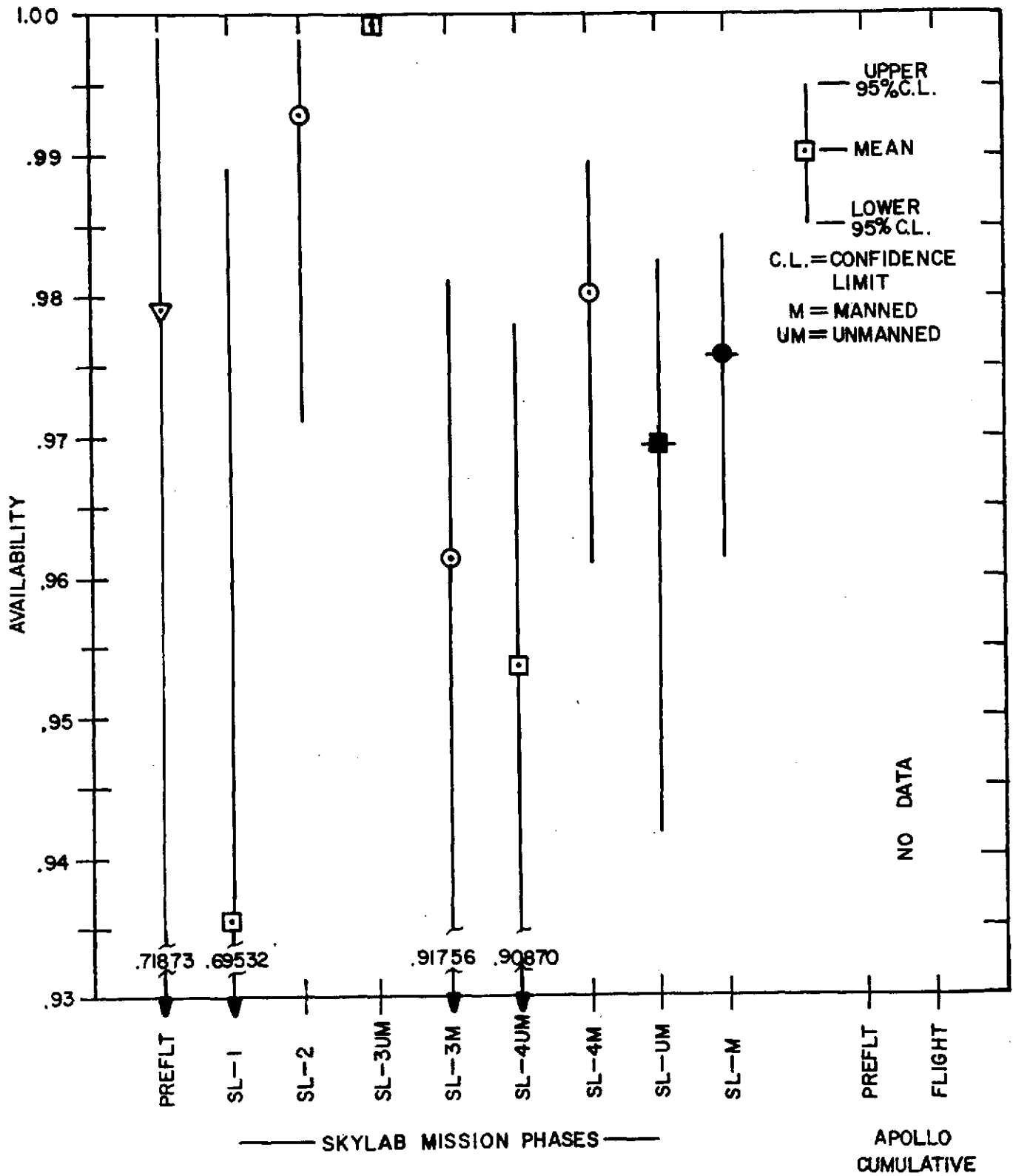
AVAILABILITY FUNCTION III

FIGURE: 6



MAJOR SUPPORT FUNCTION IV
SPACECRAFT UPLINK
AVAILABILITY FUNCTION IV

FIGURE: 7

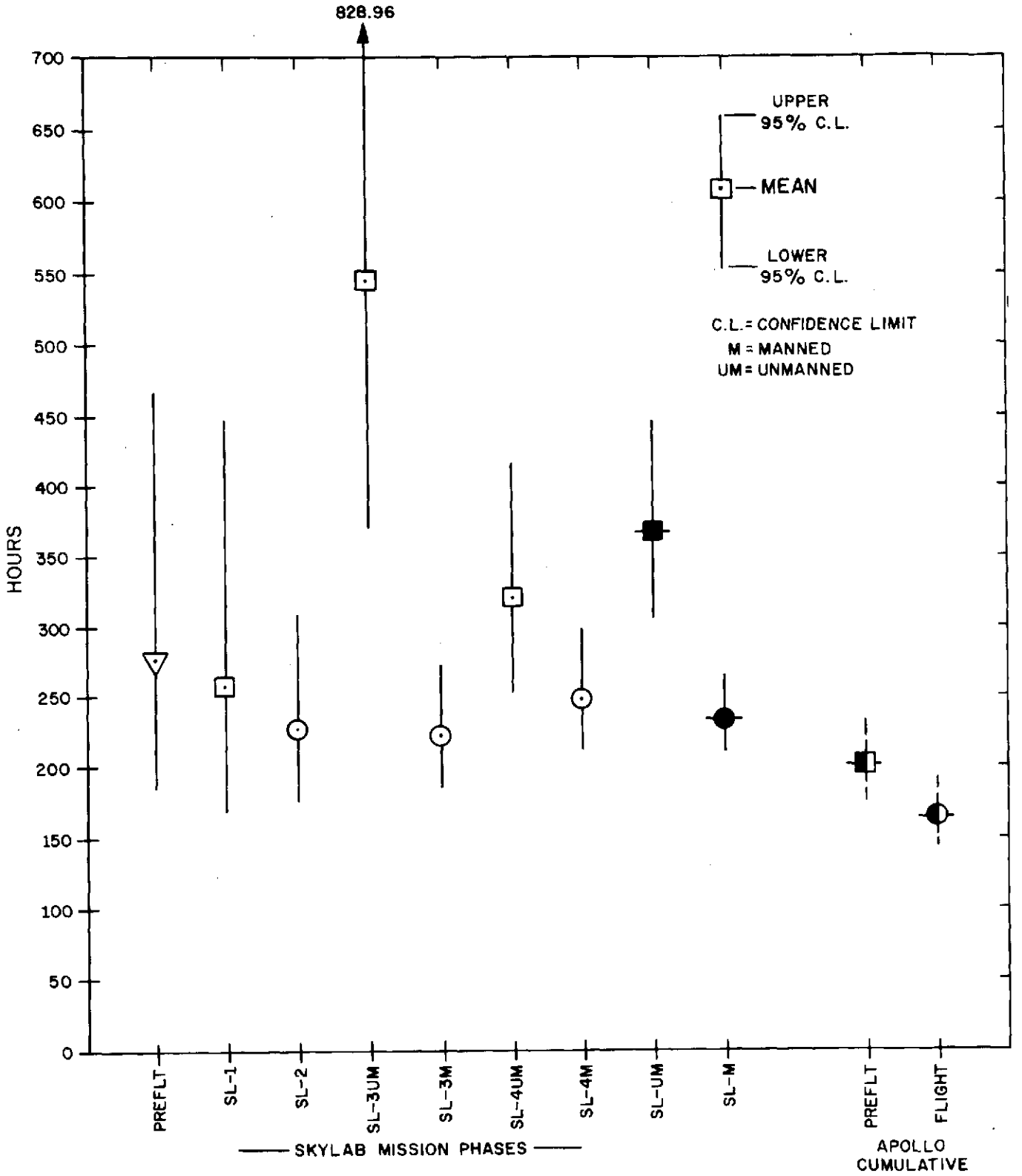


MAJOR SUPPORT FUNCTION V

SPACECRAFT TELEVISION

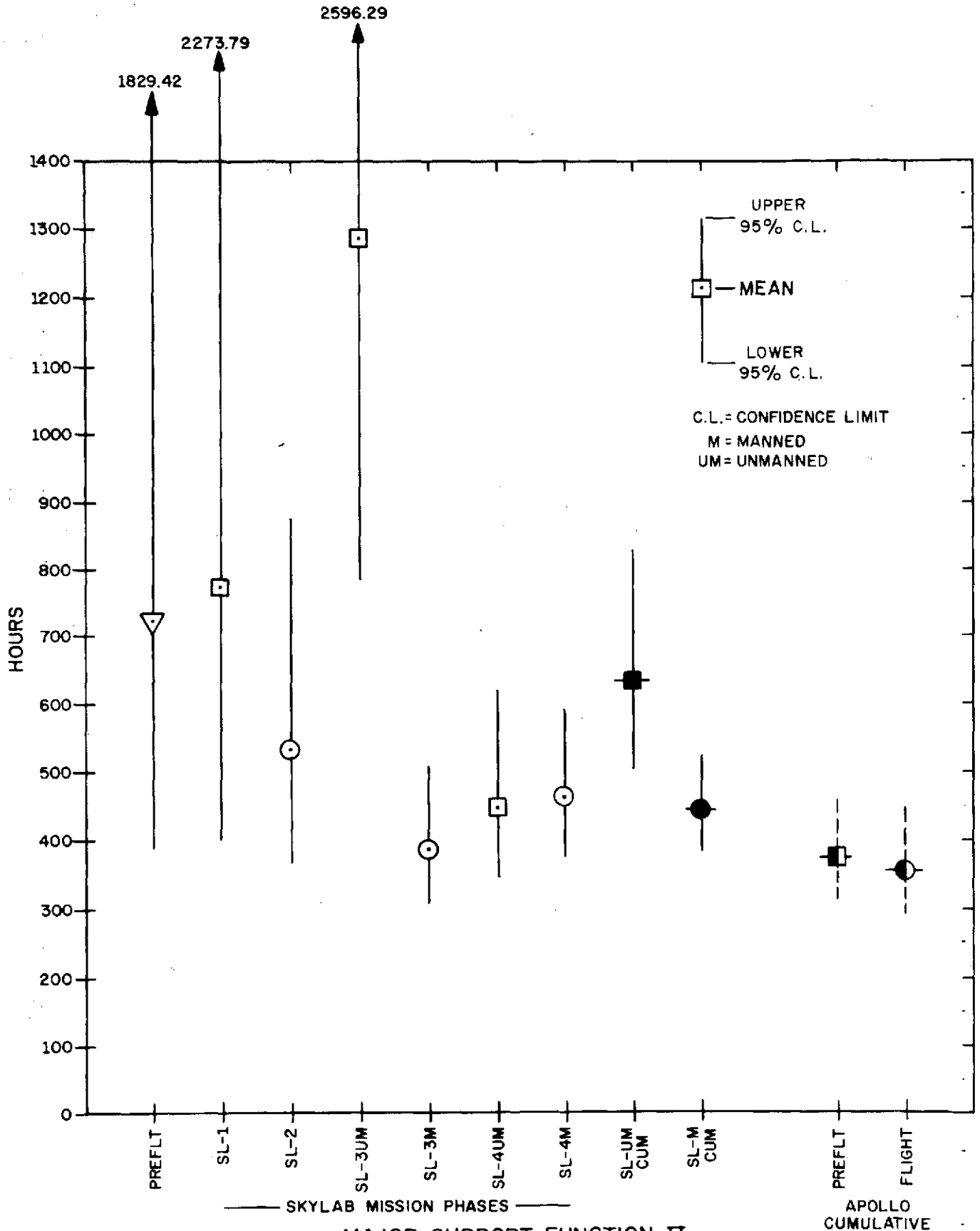
AVAILABILITY FUNCTION V

FIGURE: 8

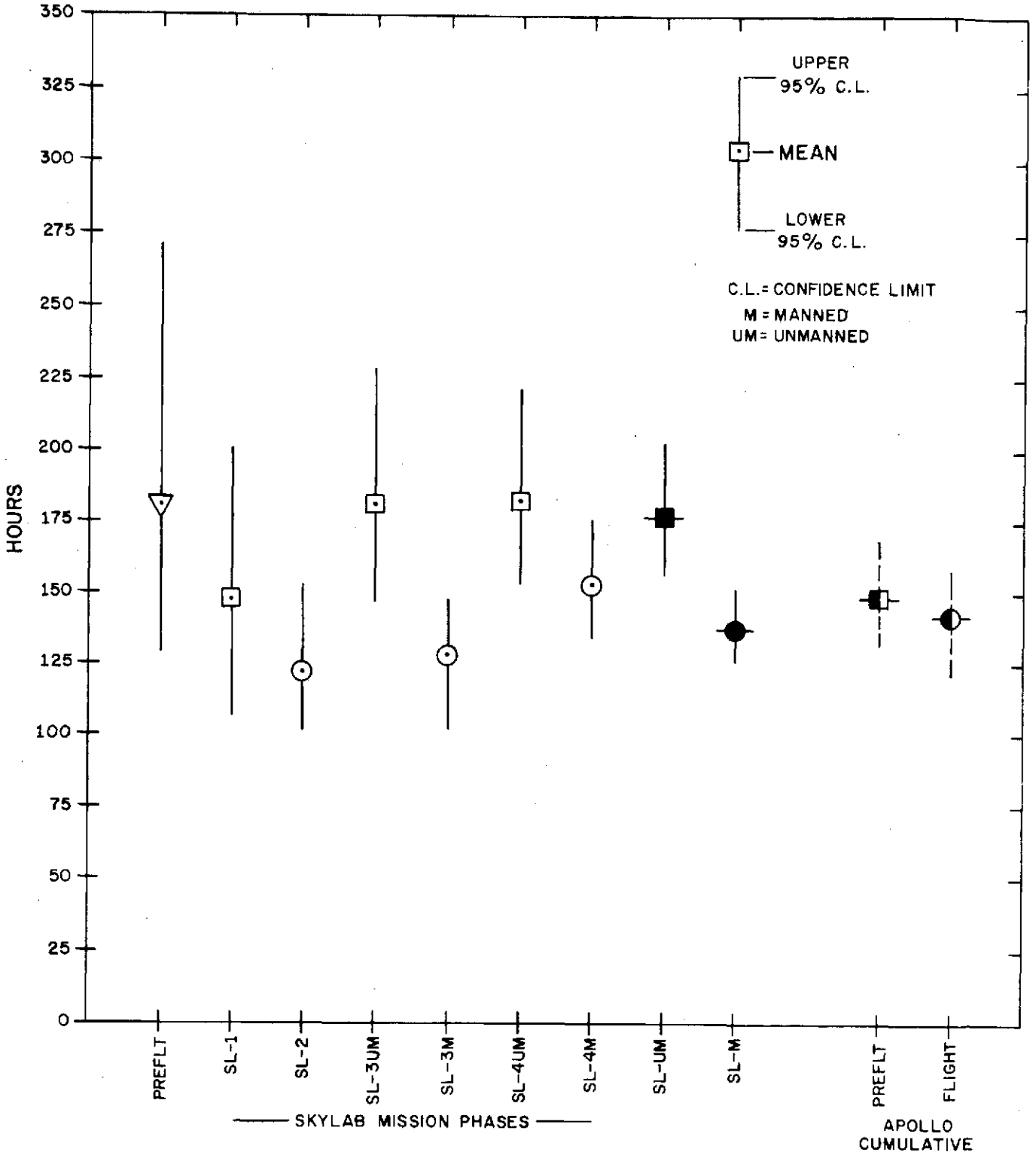


MAJOR SUPPORT FUNCTION I
SPACECRAFT TRACKING
MTBF FUNCTION I

FIGURE: **9**

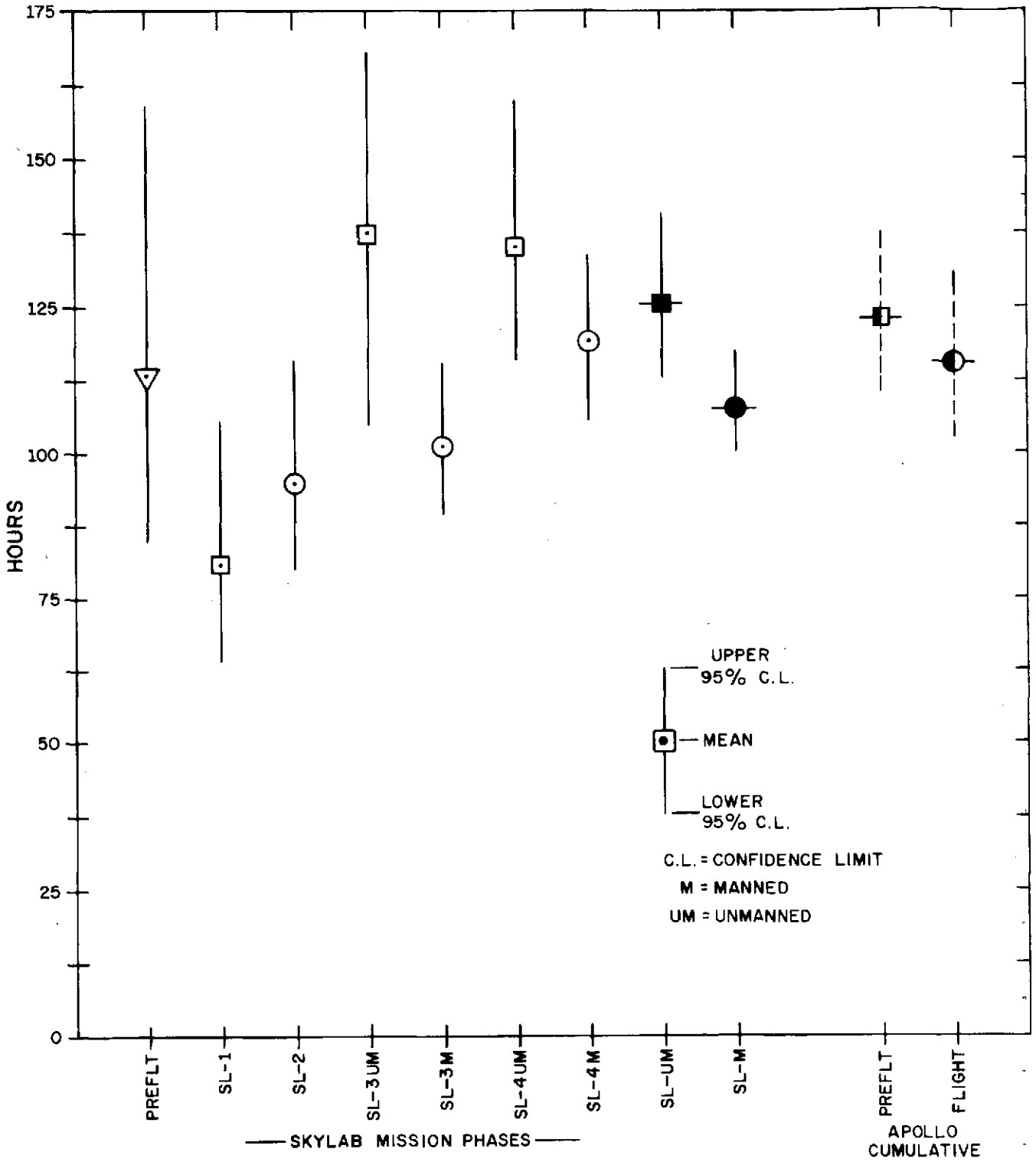


MAJOR SUPPORT FUNCTION II
SPACECRAFT COMMUNICATIONS-VOICE
MTBF FUNCTION II



MAJOR SUPPORT FUNCTION III
SPACECRAFT MONITORING
MTBF FUNCTION III

FIGURE: 11

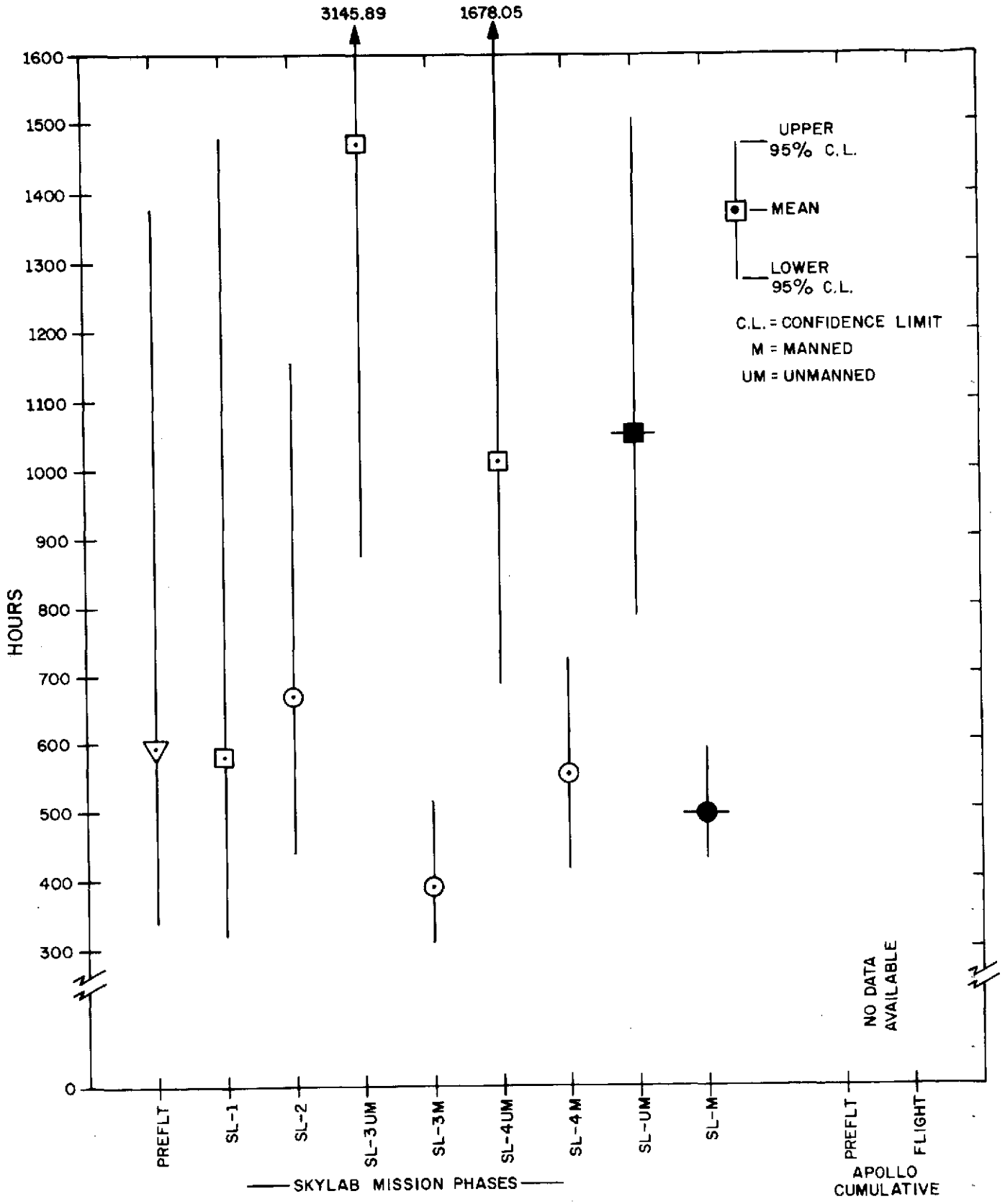


MAJOR SUPPORT FUNCTION IV

SPACECRAFT UPLINK-CMD

MTBF FUNCTION IV

FIGURE: **12**



MAJOR SUPPORT FUNCTION Ⅴ

SPACECRAFT TELEVISION

MTBF FUNCTION Ⅴ

FIGURE: **13**

V. DISCUSSION

A direct comparison of the observed operational MTBF and availabilities of SKYLAB support to that of the Apollo cumulative is not valid. SKYLAB reliability values are based on more equipments with the additional UHF and VHF systems in support. These equipments have not been modeled as redundant to the S-band systems but as systems in support of additional TLM and CMD requirements for the SKYLAB Mission. With this consideration in mind, one can then make a rough comparison of the values for SKYLAB versus Apollo cumulatives as shown in Figure 4 through Figure 13. This comparison of MTBF and availability values as shown in these Figures indicates there is no significant difference between STDN support for SKYLAB and the support of the Apollo flights.

VI. CONCLUSIONS

1. From the foregoing analysis it is concluded that the STDN experienced no difficulty in supporting the SKYLAB Mission and the extended support time required.

2. Support during SKYLAB 4 (Manned) phase compares favorably with that of the SKYLAB 1 phase.

APPENDIX I

EQUIPMENT SUBSYSTEM CATEGORIES

APPENDIX I

EQUIPMENT SUBSYSTEM CATEGORIES FOR RELIABILITY DATA (73-1)

Cat. No.	Subsystem Categories
1	USB Antenna and Mount - (General)
2	Microwave Circuitry/Feed/Diplexers/Filter Circulators; Mixers, x 32 Mult.
3	Main Paramp; Power Supply and Klystron (Other Preamp.)
13*	Maser
4	XY Drive, HA/DEC Drive, Mechanical/Hydraulic; Motors, Gears, Brakes, etc.
5	USB Acquisition Antenna - (General)
6	Feed/Microwave Circuitry
7	Uncooled Paramp; Power Supply and Klystron
8	USB Antenna Servo and Control Unit - (General)
9	Electro/Mechanical; Encoders, Tachometers, Synchros, etc.
10	Electrical; Amplifiers, Compensating Networks D/A Converters, etc.
11	Control Console, Ball Tab, Angle Readouts, etc.
12	Interface to Acq. Bus.
13*	USB Antenna and Mount - Maser
	USB Receiver/Exciter
14	Rcvr. - Ref. (Sum) Channel, including 20 Mc VCO and Multipliers
15	Rcvr. - Angle Channels
16	Rcvr. - PM Telemetry
17	Rcvr. - Range and Range Rate Group

* Listed twice: in numerical order and with related equipment

APPENDIX I (Continued)

Cat. No.	Subsystem Categories
18	Exciter
19	Receiver. - General
20	Mark-I Ranging Subsystems
21	Apollo Split Site Timing Interference
22*	Voice Demod (Wing)
23*	TLM Demod (Wing)
26	Antenna Position Programmer
27*	NASCOM
30	Tracking Data Processor
36	Decommutation System Distribution Unit (DSDU)
37	Signal Data Demodulator Signal Matrix
38	PM Mode Buffer Amp/TLM Subcarrier Demod/ Voice Subcarrier Demod/AM Key Demod
39	Voice Demod (Prime)
22*	Voice Demod (Wing)
40	FM Carrier Demod/FM Biomed Subcarrier Demods
41	TLM Demod (Prime)
42	SIV-B TLM Receiver
23*	TLM Demod (Wing)
43	Uplink Subcarrier Oscillators
44	30 kHz Voice
45	70 kHz Data
46	Power Amplifier, P. A. Power Supply and Control
47	Power Amp Combiner

* Listed twice: in numerical order and with related equipment

APPENDIX I (Continued)

Cat. No.	Subsystem Categories
48	Precision Frequency Source, 1 Crystal
49	Precision Frequency Source, Cesium
50	Precision Frequency Source, Rubudium
51	Timing
57	Up-Data Buffer
58*	Station Power (Wing)
60	Verification Receiver
61	Systems Monitor
62	Patch Panel
63	Events Recorder/Chart Recorders
64	Other Analog, Recorders, X-Y Plotters (e.g., Acq. Aid Data)
65	Collimation Tower; Collimation Equipment
66	Antenna/Microwave
67	Transponder Simulator/Transmitter
68	USB Antenna Transponder Receiver/Transmitter
	Station Prime Power and Other Facilities
69	Station Facilities
70	Station Power (Single, Dual or Prime [85' Ant.])
58*	Station Power (Wing [85' Ant.])
71*	EMU (CMD)
72	Other Facilities; Air Conditioning, etc.

* Listed twice: in numerical order and with related equipment

APPENDIX I (Continued)

Cat. No.	Data Processing Equipment
73	Telemetry Decommutators (PCM's)
77*	UHF (General)
78	PCM Simulator
79	Tape Recorders for Data/Voice Recorder Matrix
80	M-22 VR-3600's Wideband Recorders
81	M-25 FR-1100 Narrowband Recorders
82	Recording VCO's, IRIG, Other
83	Digital Data Distribution Switchboard (DDDS, SB 1299)
	Telemetry Data Processing
85	642 Computer for Telemetry (642-B, TLM) (1230 UNIVAC)**
86	Telemetry Input/Output Console (TLM I/O, 1232A)
87	Telemetry Magnetic Tape Unit (MTU 1540, TLM) - Tape Handler
88	Telemetry Teletype (TTY 1250 TLM)
89	Telemetry Adapter for Telemetry (TTY Adapt 1259, TLM)
	Subsystem Categories
90	Expanded Memory Unit (TLM)
71*	Expanded Memory Unit (CMD)
	Command Data Processing
92	642-B Computer for Command (642-B, CMD) (1230 UNIVAC)**
93	Command Input/Output Console (CMD I/O, 1232A)
94	Command Magnetic Tape Unit (MTU 1540, CMD) - Tape Handler

* Listed twice: in numerical order and with related equipment

** VANGUARD Computers

APPENDIX I (Continued)

Cat. No.	Subsystem Categories
95	Command Teletype (TTY 1259, CMD)
96	Teletype Adapter for Command (TTY Adapt 1259, CMD)
97	High Speed Printer (s) (1222)
98	High Speed Printer Buffer/Translator (TP 4000)
99	Timing Interface System Adapter (ISA Type 1000)
100	Data Transmission Unit for Telemetry (DTU 2010, TLM)
101	Data Transmission Unit for Command (DTU 2010, CMD)
102	1218 Computer(s)
103	Teletype
104	Teletype Adapter
105	Paper Tape Readers/Punch/1218 MTU
106	Digital Consoles and Displays
107	Computer Address Matrix (CAM)
108	Console Computer Interface Adapter (CCIA)
109	Memory Character Vector Generator (MCVG)
110	Communccation Link (Wing) Microwave, CATV, Cable/ Terminal Equipment
	Communication Equipment (NASCOM and Other Network Communications)
112	Data Modems
113	Communication Teletype(s) ASR, etc.)
114	Voice Lines, Terminal Equipment

* Listed twice: in numerical order and with related equipment

APPENDIX I (Continued)

Cat. No.	Communication Equipment (NASCOM and Other Network Communications)
115	HF Radio and Modems
116	HF Voice Radio Equipment
27*	NASCOM
	Acquisition Aid, VHF Telemetry Equipment
117	Acquisition Aid Antenna (Helix, Teltrac)/Coupling and RF Circuitry, Diplexer, Multiplexer, Preamps/ RF Patch Panel
118	Acq. Aid; Receiver/AZ, EL, and Sum Channels
	Subsystem Categories
119	Acq. Aid; Pedestal/Electric and Electro/Mechanical Servo
120	Acq. Aid; Position Indicators and Servo Control Units
121	Acq. Aid; Interface to Acq. Bus.
122	Acquisition Bus.
123	VHF Telemetry Receivers, Spectrum Display Units
124	VHF (UF) Voice Transmitter/Receiver
125	UHF Command Antenna/RF Feed, Coupling
126	UHF Command Antenna/Pedestal/Servo and Servo Control/ Drive/Acq. Bus. Interface
127	UHF Command Transmitter (FRW-2A) (2)
128	UHF Command P. A. (240 D-2) (2)
129	Verification Receiver (AN/FRW-2A)

* Listed twice: in numerical order and with related equipment

APPENDIX I (Continued)

Cat. No.	Subsystem Categories
130	Digital Command System (DCS)
77*	UHF (General)
	C-Band Radar Equipment
131	Modulator, Transmitter and Transmitter Power Supplies
132	Receiver; Sum Channel/Angle Channels
133	Range Tracking Loop, Including Computing Equipment
134	Angle Servo and Servo Control Equipment
135	Antenna/Feed Microwave/Preamp/TR Device, etc.
	Subsystem Categories
136	Antenna Mount/Servo Drive/Angle Synchro, Tachometer; Encoder Feedback
137	Interface to Acq. Bus.
138	Designate Computer
139	Data Outputs (Range, Angle Synchros to Acq. Bus)
140	Digital Computing Equipment; Data Timing, Data Conversion and Formatting for Transmission, Range and Angle Data Output, 410/C Computer
141	Radar Power Supplies
142	Slow-Scan TV and Monitor
143	SPAN
145	ASTAM (1218)
144	1218 MTU

* Listed twice: in numerical order and with related equi ment

APPENDIX I (Continued)

Cat. No.	Subsystem Categories
146	SCO - 124 kHz SCO
147	DQM
148	TV Switching Matrix (Dynair 5100R)
149	Filtering and processing system includes: TVISCU, Filters, Distribution Amplifiers, Processing Amplifier.
150	Aria Misc.
151	Output system includes: Video Switches, VIT Insert, Distribution Amplifiers
152	Video Tape Recorders: VR-660C, VR-1100
153	Time/Voice Correlator (TVC)
154	VHF Misc.
160	Van Misc.

APPENDIX II

MISSION SUPPORT FUNCTIONS

APPENDIX II

LIST OF MISSION SUPPORT FUNCTIONS FOR EACH MSFN SITE

I. Determine Position of Spacecraft vs Time (Tracking/ Navigation).

- A. Receive Position/Time Data from MCC or MSFN.
- B. Acquire and Track Spacecraft and Its Signals.
- C. Transmit Spacecraft Position/Time to MCC.
- D. Record Spacecraft Position/Time On Site.

II. Maintain Space Communications with Spacecraft.

- A. Receive Voice from MCC.
- B. Transmit Voice to Spacecraft.
- C. Receive Voice from Spacecraft.
- D. Transmit Voice to MCC.
- E. Record Voice On Site.

III. Monitor Spacecraft Status and Systems.

- A. Receive Telemetry from Spacecraft.
- B. Process and Transmit Telemetry Summaries to MCC.
- C. Record Telemetry On Site.

Appendix II, Continued

IV. Send Commands/Other Up-Data to Spacecraft.

A. Receive Commands from MCC.

B. Process Command Data.

C. Transmit Up-Data to Spacecraft.

D. Verify that Up-Data Is Transmitted.

E. Verify that Up-Data Is Received.

F. Transmit Command Verification to MCC.

G. Record Command History On Site.

V. Receive and Process Television from Spacecraft

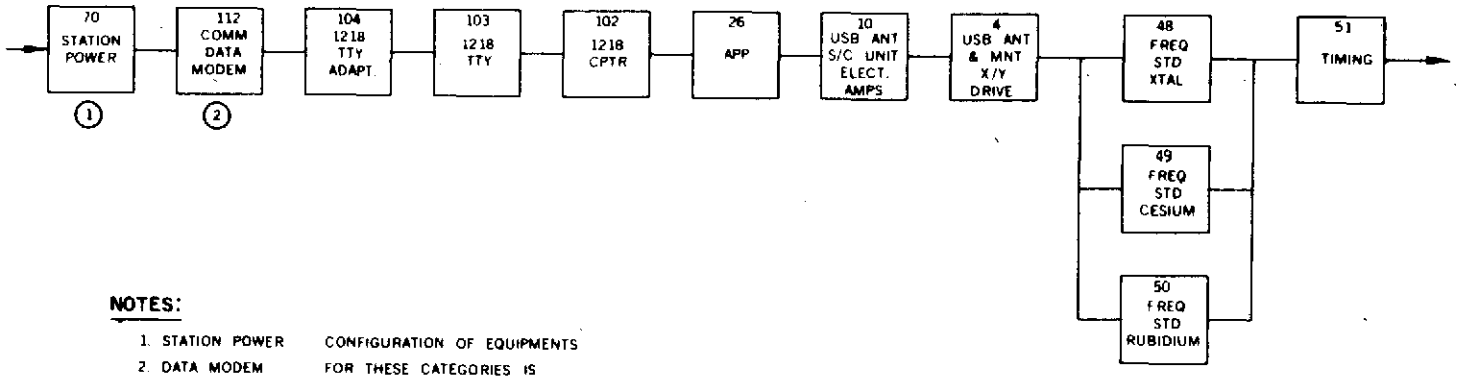
A. Receive TV from Spacecraft

B. Process and Transmit TV to User

C. Record TV On Site.

APPENDIX III

BASIC RELIABILITY MODELS



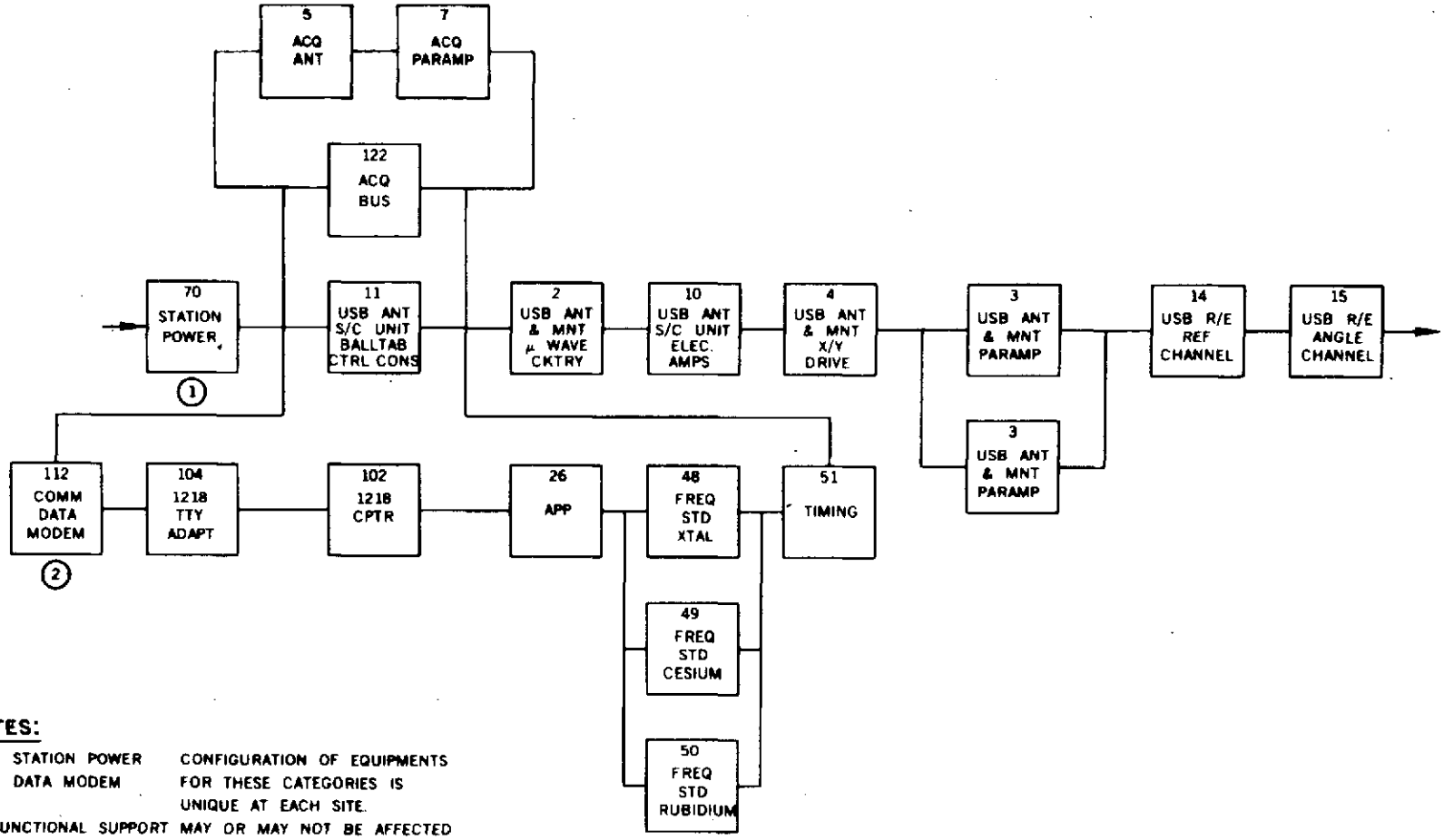
NOTES:

1. STATION POWER — CONFIGURATION OF EQUIPMENTS
2. DATA MODEM — FOR THESE CATEGORIES IS UNIQUE AT EACH SITE.

FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 1

I-A RECEIVE AND PROCESS POSITION/TIME FROM MCC OR STDN



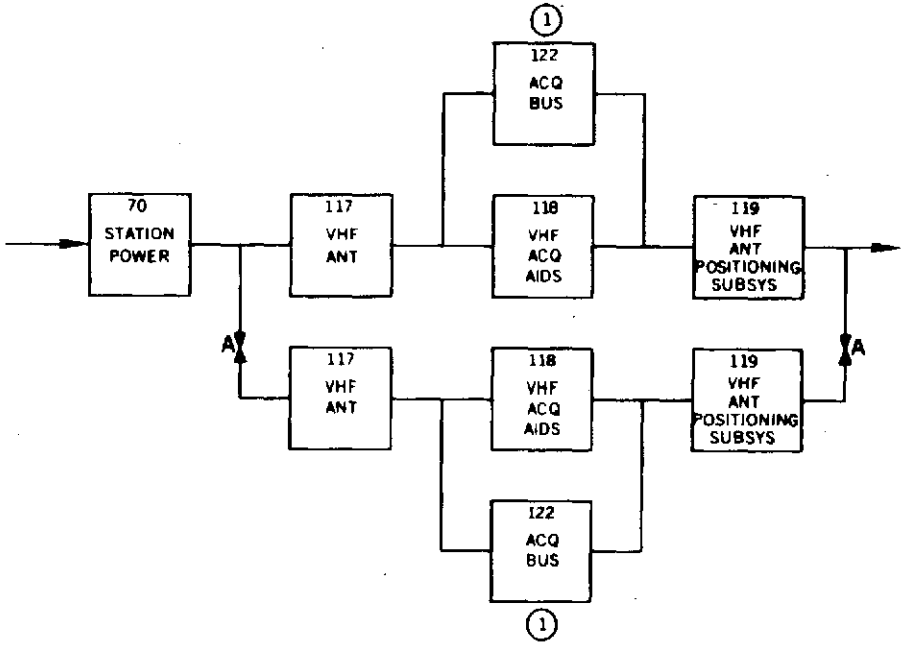
NOTES:

1. STATION POWER — CONFIGURATION OF EQUIPMENTS
2. DATA MODEM — FOR THESE CATEGORIES IS UNIQUE AT EACH SITE.

FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 2A

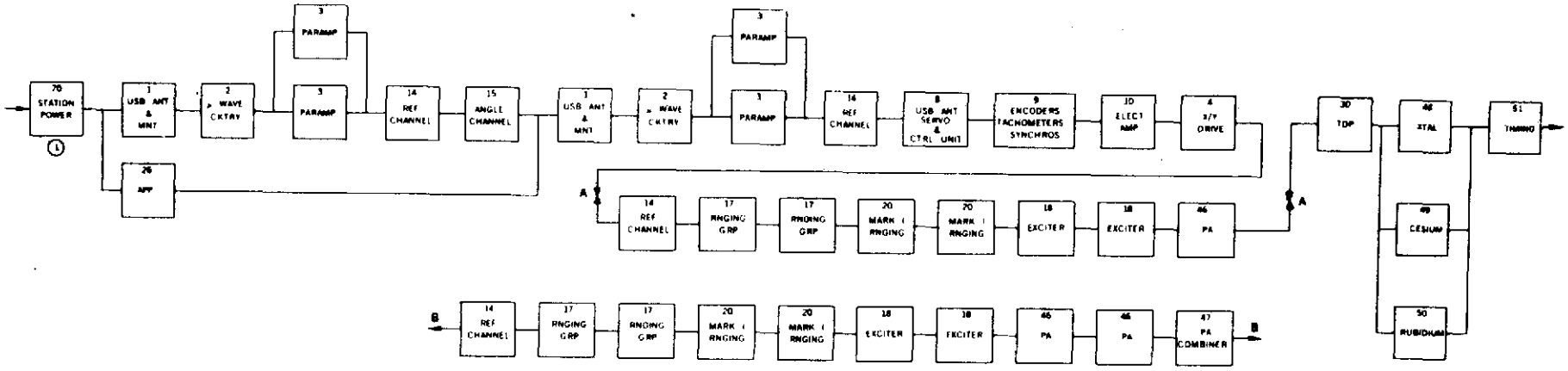
I-B ACQUIRE (USB)



NOTES:

1. A SINGLE TYPE SITE INCLUDES EQUIPMENTS LESS A–A
   A DUAL TYPE SITE INCLUDES ALL EQUIPMENTS
2. (1) SAME ACQ BUS
3. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 28
I–B ACQUIRE (VHF)



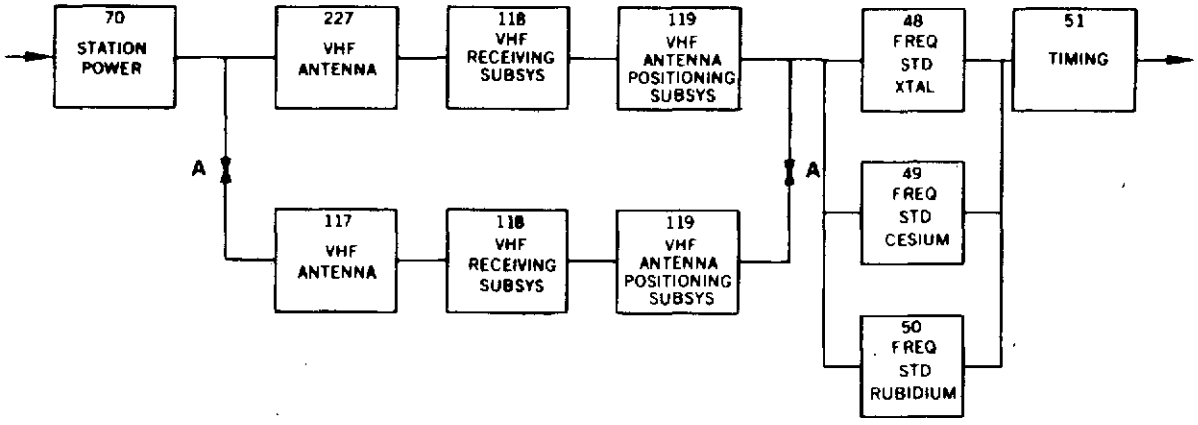
AA – 30' ANTENNA DUAL
BB – 85' ANTENNA PRIME

NOTES:

1 STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE: 3A

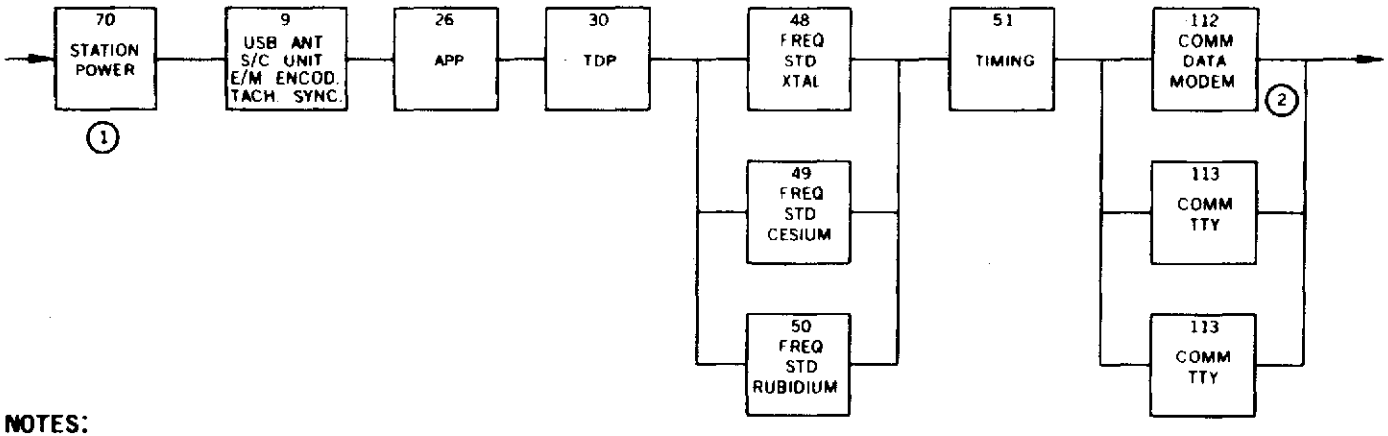
I–C TRACKING (RANGE & ANGLE) USB



NOTES:

1. TWO TYPES OF SITES (SINGLE VHF ACQ AID, DUAL VHF ACQ AID) ARE REPRESENTED BY THE DIAGRAM.
2. A SINGLE TYPE SITE IS REPRESENTED BY THE DIAGRAM LESS A–A EQUIPMENT BLOCKS.
3. A DUAL TYPE SITE IS REPRESENTED BY ALL EQUIPMENTS IN DIAGRAM
4. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 3B
I–C TRACKING (ANGLE) VHF

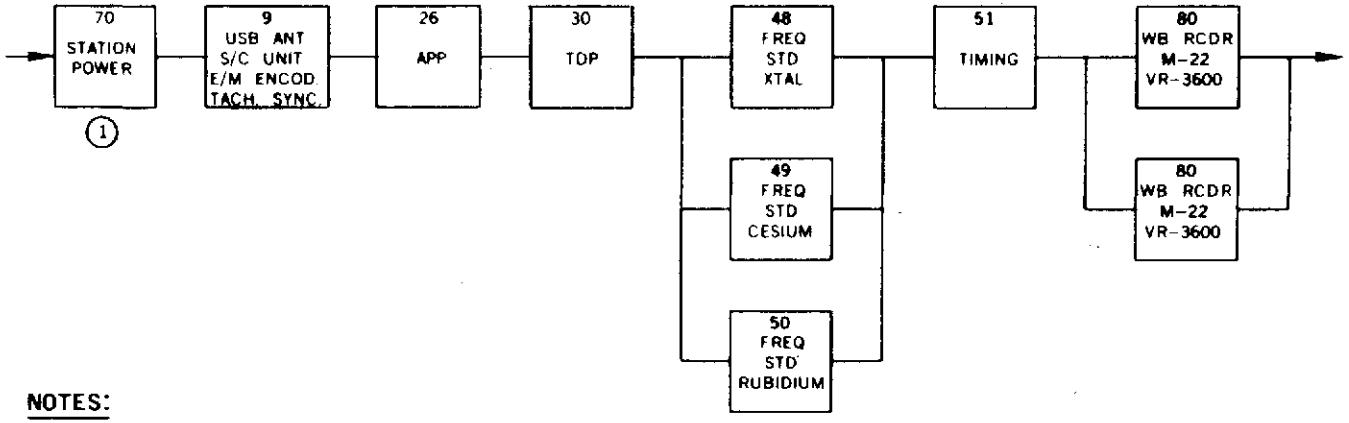


NOTES:

1. STATION POWER — CONFIGURATION OF EQUIPMENTS
2. DATA MODEM — FOR THESE CATEGORIES IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 4

I-D TRANSMIT SPACECRAFT POSITION/TIME TO MCC

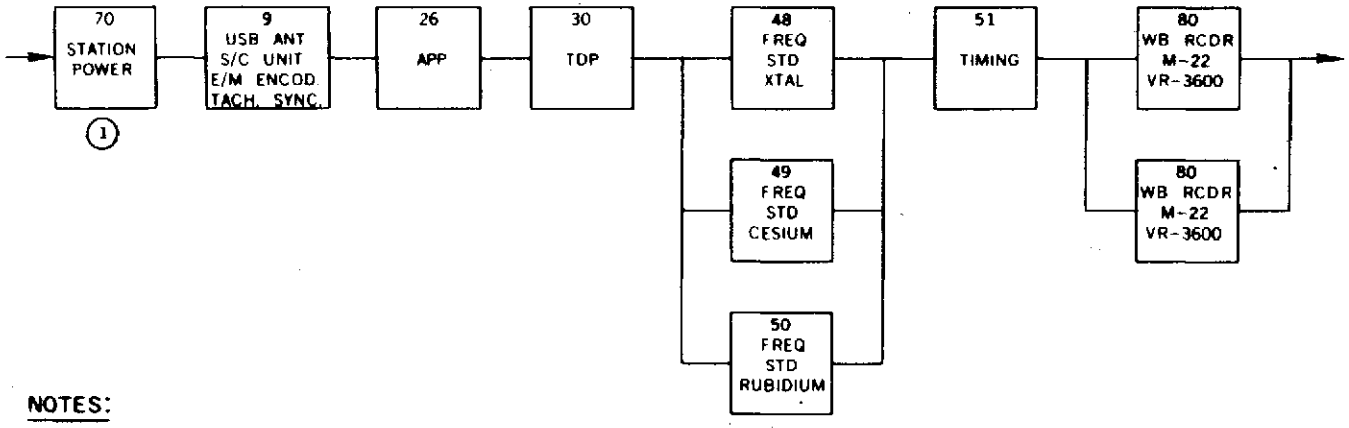


NOTES:

1. STATION POWER — CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 5

I-E RECORD SPACECRAFT POSITION/TIME AT SITE

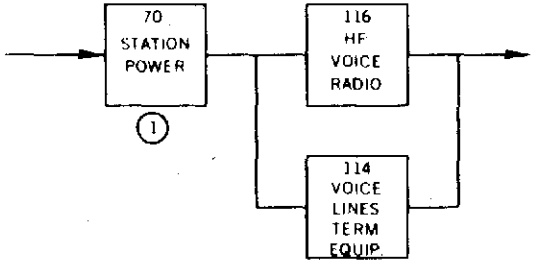


NOTES:

1. STATION POWER — CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 5

I-E RECORD SPACECRAFT POSITION/TIME AT SITE

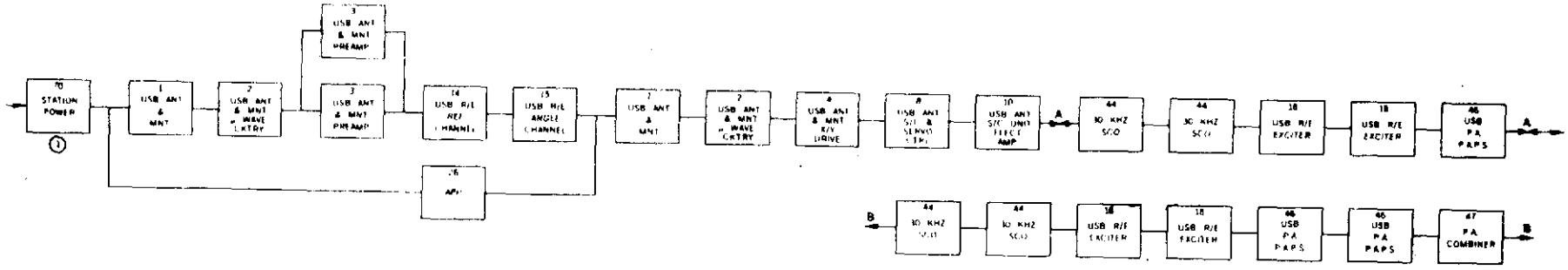


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE: 6

Ⅱ–A RECEIVE VOICE FROM MCC



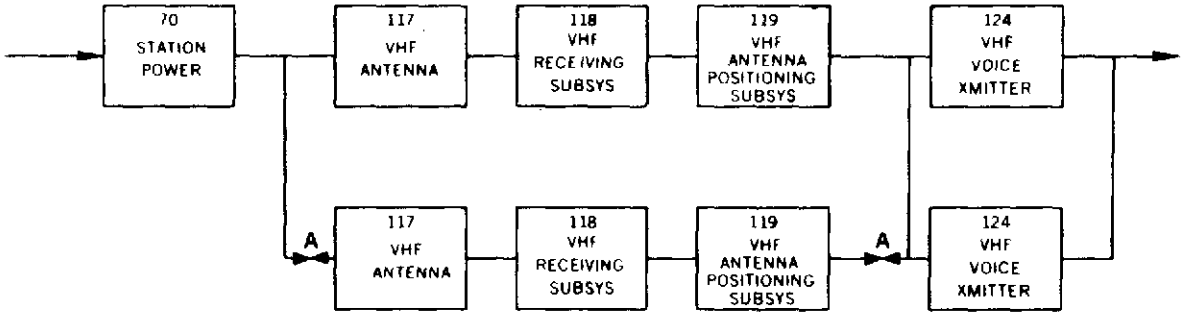
AA – 30' ANTENNA DUAL
BB – 85' ANTENNA DUAL

NOTES:

1. STATION POWER – CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 7A

□–B TRANSMIT VOICE TO SPACECRAFT (USB)

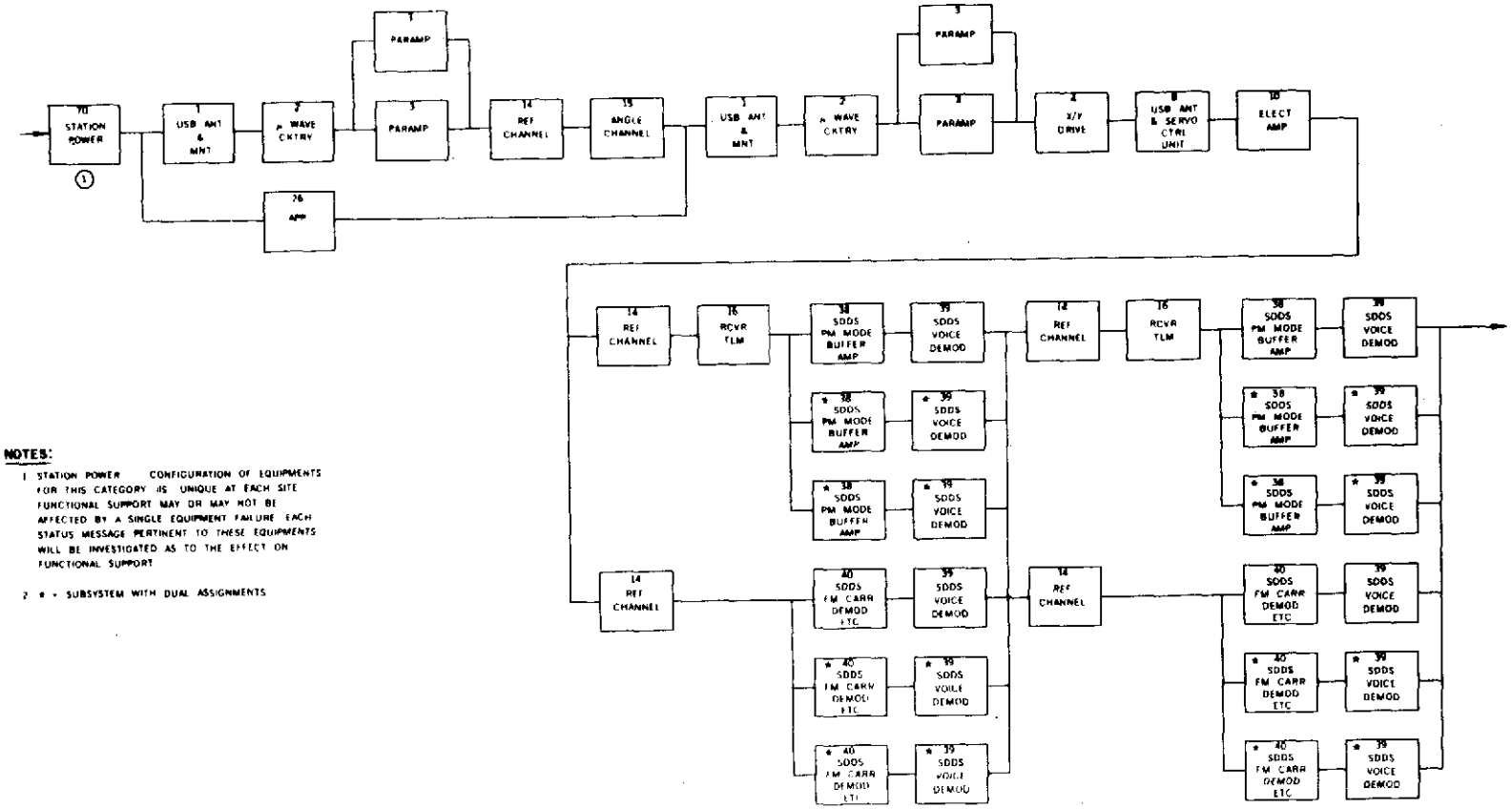


NOTES:

1. TWO TYPES OF SITES (SINGLE VHF AND DUAL VHF) ARE REPRESENTED BY THE DIAGRAM.
2. A SINGLE TYPE SITE IS REPRESENTED BY THE DIAGRAM LESS **A–A** EQUIPMENT BLOCKS.
3. A DUAL TYPE SITE IS REPRESENTED BY ALL THE EQUIPMENTS IN THE DIAGRAM.
4. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 7B

II–B TRANSMIT VOICE TO SPACECRAFT (VHF)



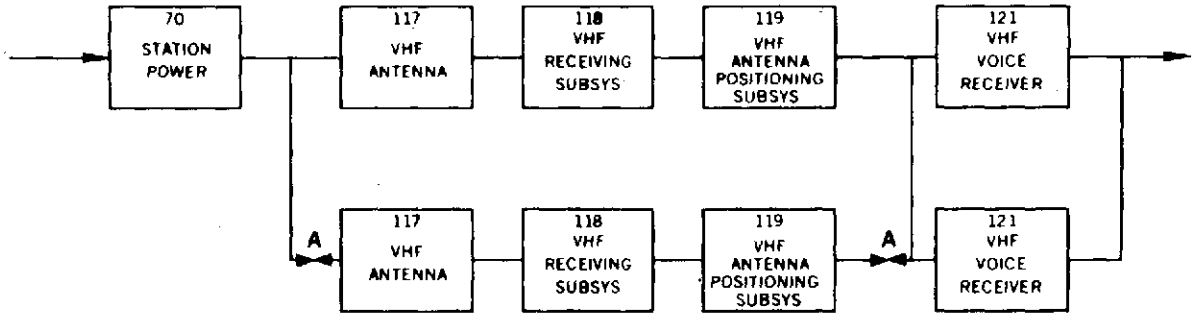
NOTES:

1 STATION POWER — CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

2 * = SUBSYSTEM WITH DUAL ASSIGNMENTS

FIGURE: 8A

Ω–C RECEIVE VOICE FROM SPACECRAFT (USB)

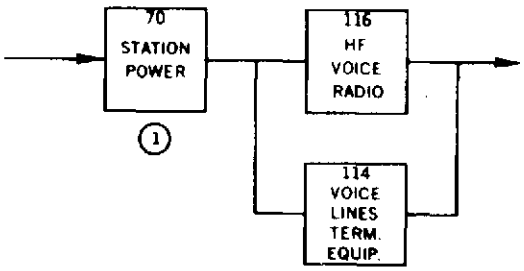


NOTES:

1. TWO TYPES OF SITES (SINGLE VHF AND DUAL VHF) ARE REPRESENTED BY THE DIAGRAM.
2. A SINGLE TYPE SITE IS REPRESENTED BY THE DIAGRAM LESS A–A EQUIPMENT BLOCKS.
3. A DUAL TYPE SITE IS REPRESENTED BY ALL THE EQUIPMENTS IN THE DIAGRAM.
4. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 88

II–C RECEIVE VOICE FROM SPACECRAFT (VHF)

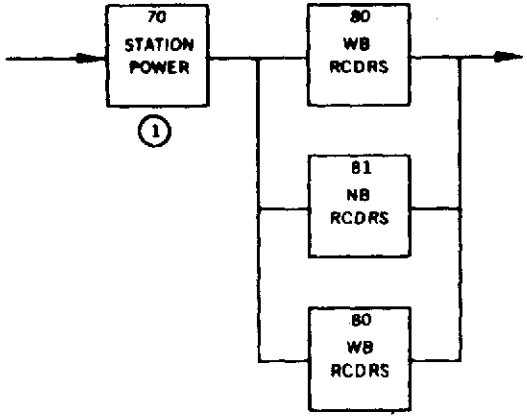


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 9

II-D TRANSMIT VOICE TO MCC

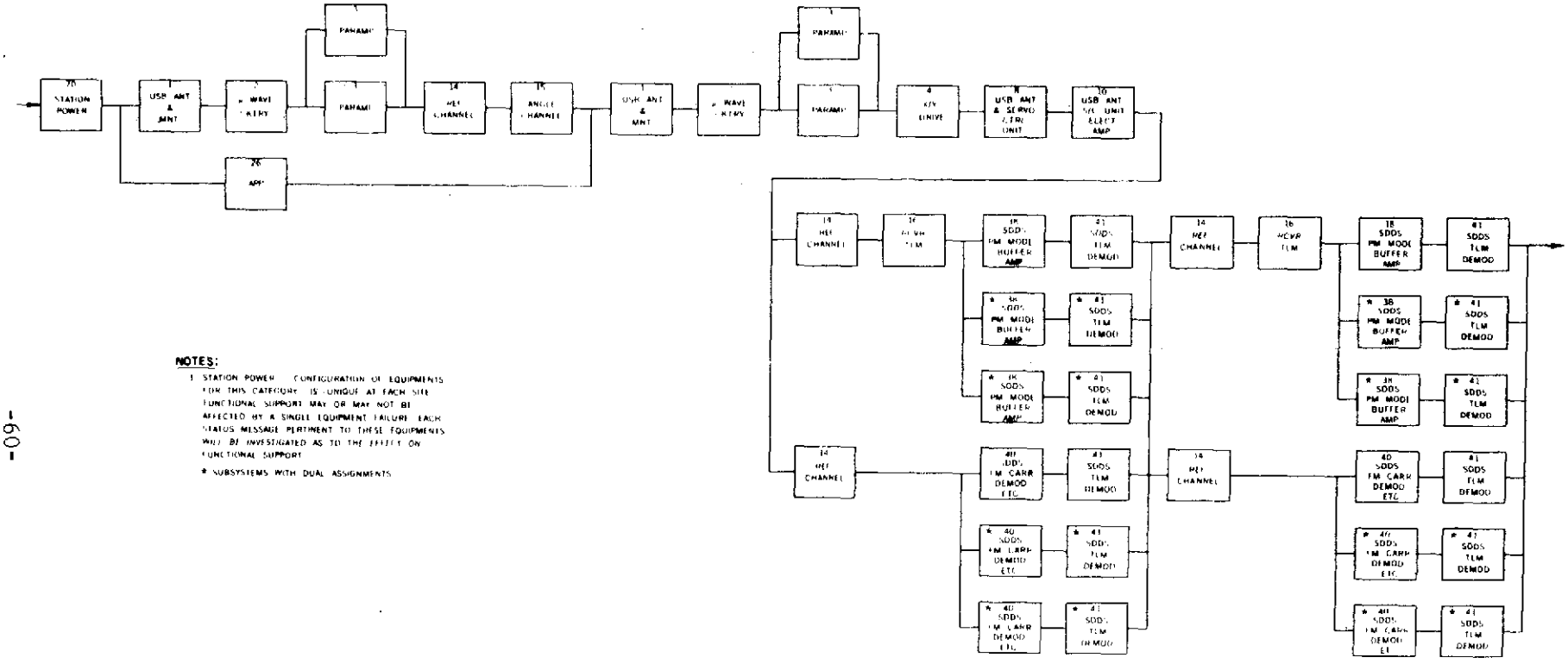


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 10

II-E RECORD VOICE ON SITE



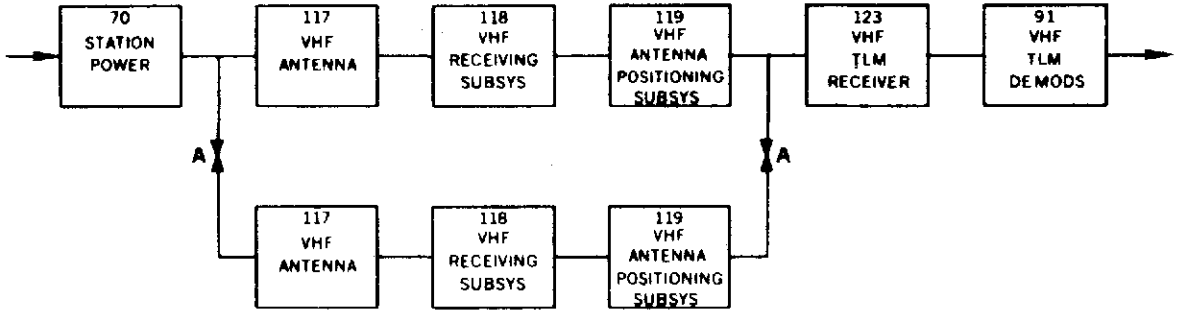
NOTES:

1. STATION POWER - CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

* SUBSYSTEMS WITH DUAL ASSIGNMENTS

FIGURE: 11A

III-A RECEIVE TLM FROM SPACECRAFT (USB)

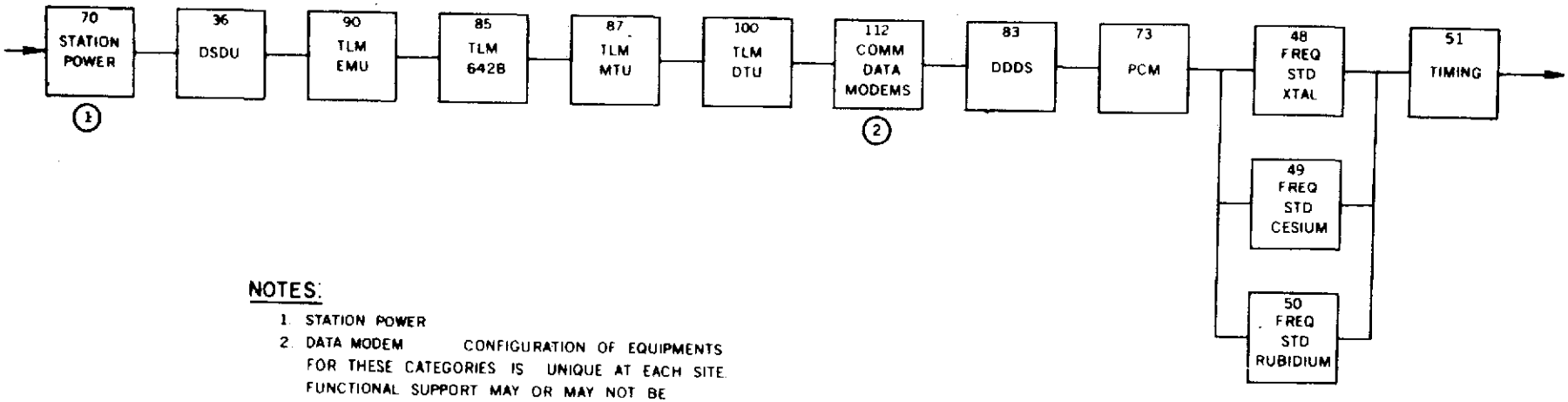


NOTES:

1. TWO TYPES OF SITES (SINGLE VHF AND DUAL VHF) ARE REPRESENTED BY THE DIAGRAM.
2. A SINGLE TYPE SITE IS REPRESENTED BY THE DIAGRAM LESS A EQUIPMENT BLOCKS.
3. A DUAL TYPE SITE IS REPRESENTED BY ALL THE EQUIPMENTS IN THE DIAGRAM.
4. STATION POWER. CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE: 11B

III–A RECEIVE TLM FROM SPACECRAFT (VHF)

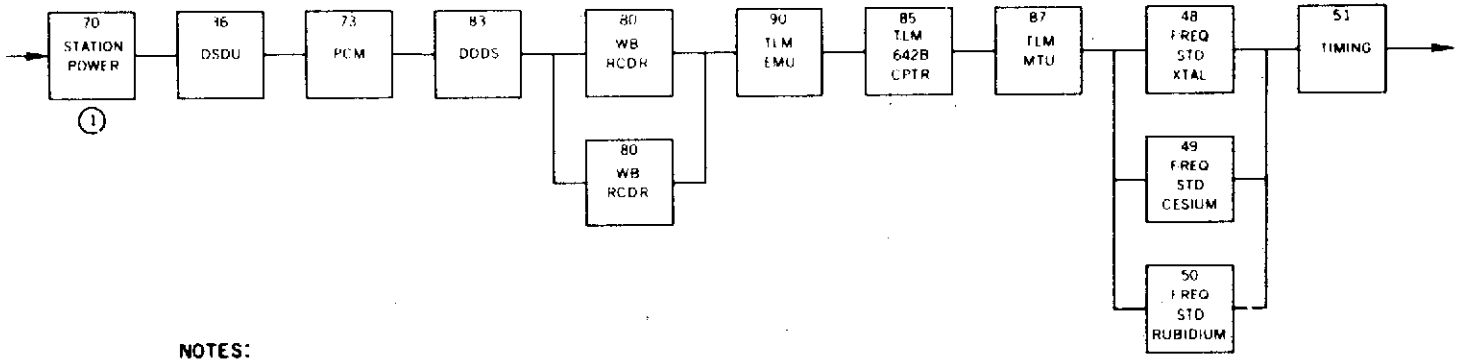


NOTES:

1. STATION POWER
2. DATA MODEM CONFIGURATION OF EQUIPMENTS FOR THESE CATEGORIES IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 12

III–B PROCESS AND TRANSMIT TLM TO MCC

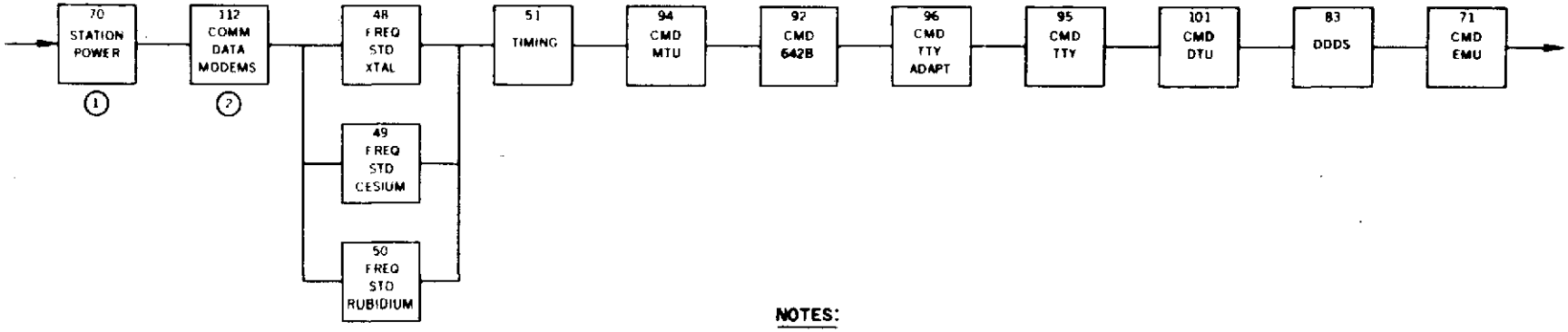


NOTES:

1 STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 13

III-C PROCESS AND RECORD TLM ON SITE



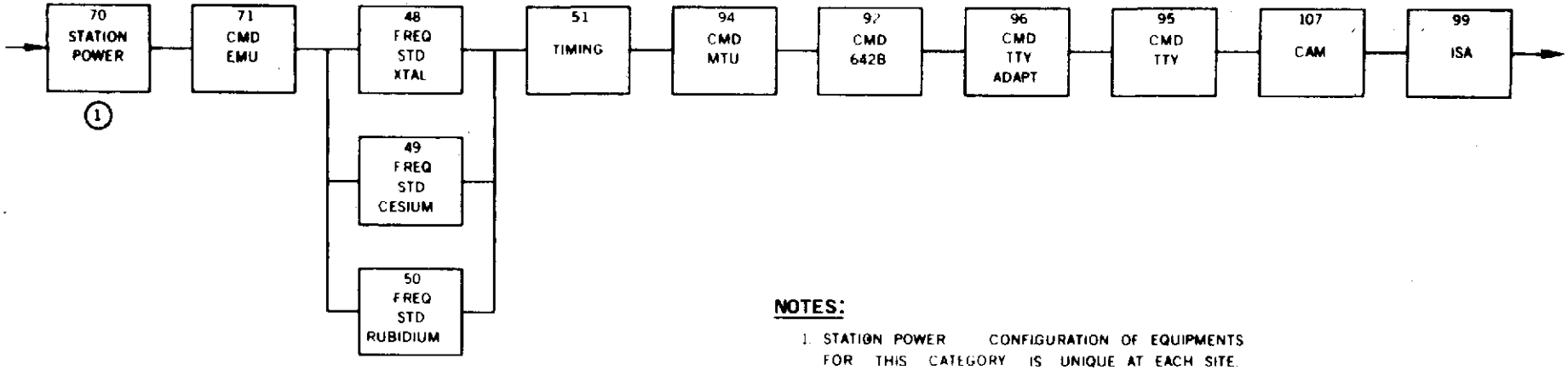
NOTES:

1 STATION POWER
2 DATA MODEM

CONFIGURATION OF EQUIPMENTS FOR THESE CATEGORIES IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE 14

Ⅳ-A RECEIVE COMMANDS FROM MCC

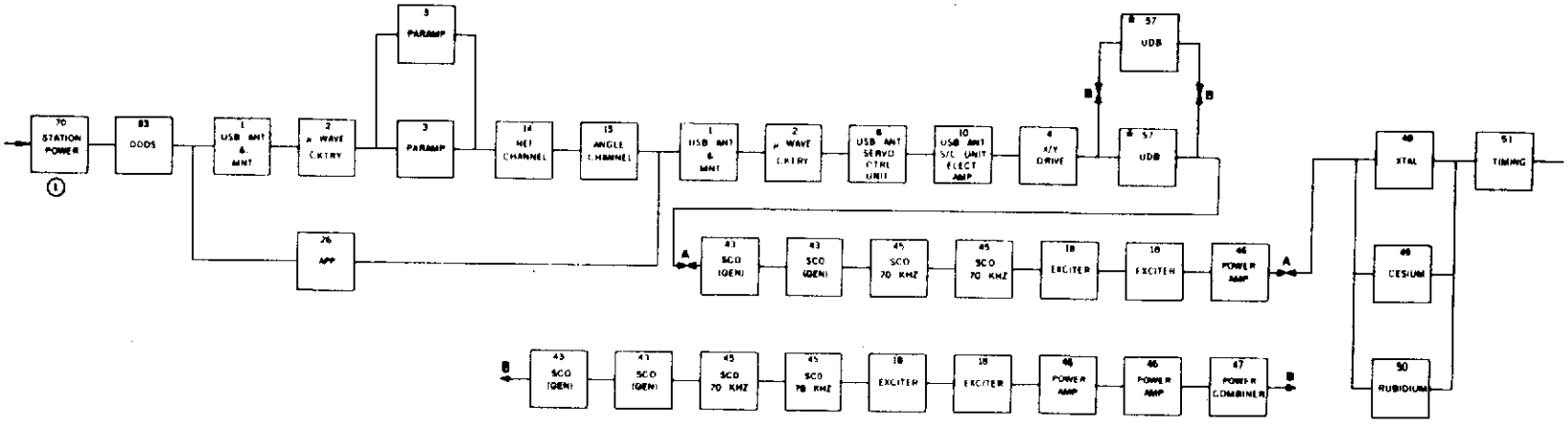


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE 15

IV-B PROCESS COMMAND DATA



NOTES:

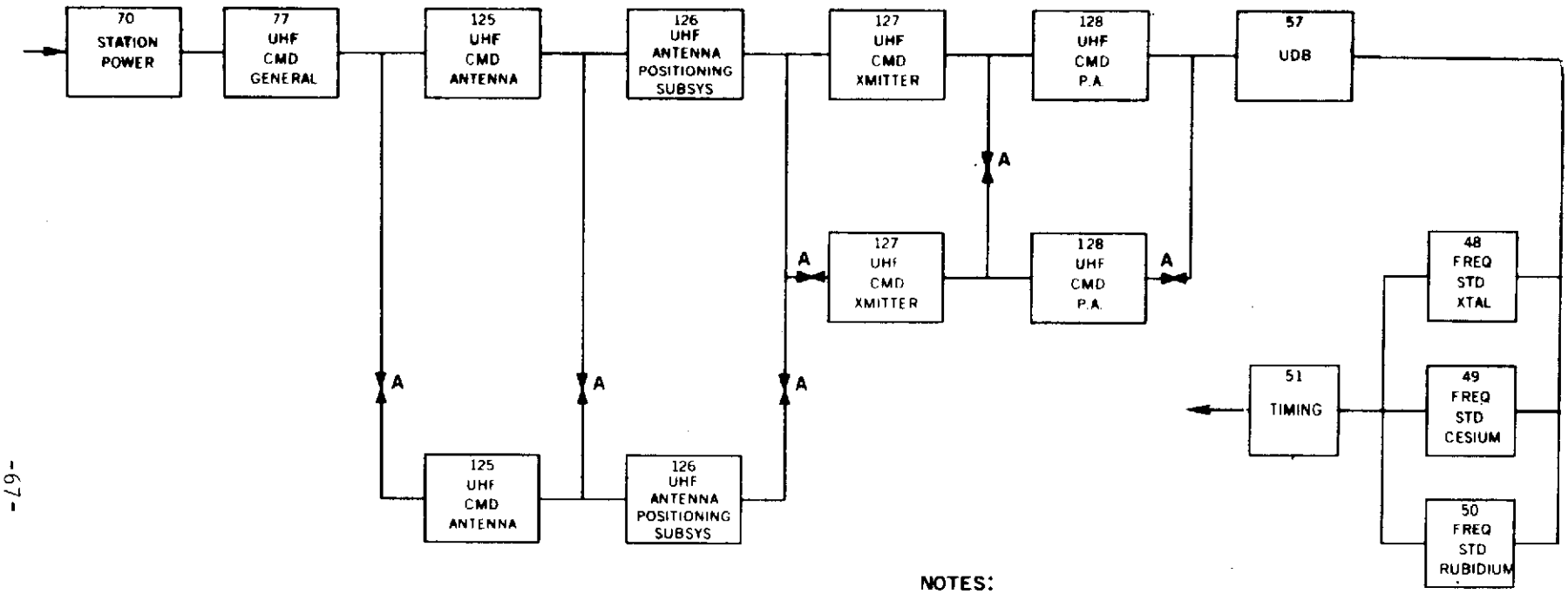
1 STATION ANTENNA CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT OF FUNCTIONAL SUPPORT

AA – 30' ANTENNA DUAL
BB – 85' ANTENNA

SUBSYSTEMS WITH DUAL ASSIGNMENTS

FIGURE: 16A

IV–C TRANSMIT UPDATA TO SPACECRAFT (USB)

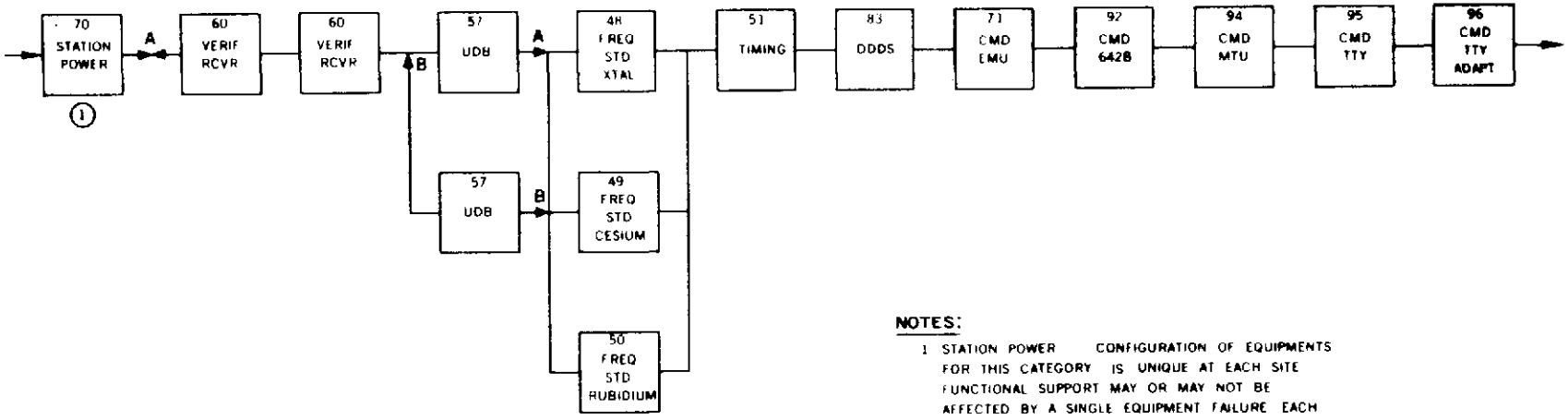


NOTES:

1. TWO TYPES OF SITES (SINGLE UHF AND DUAL UHF) ARE REPRESENTED BY THE DIAGRAM.
2. A SINGLE TYPE SITE IS REPRESENTED BY THE DIAGRAM LESS A EQUIPMENT BLOCKS.
3. A DUAL TYPE SITE IS REPRESENTED BY ALL THE EQUIPMENTS IN THE DIAGRAMS.
4. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE 168

IV-C TRANSMIT UPDATA TO SPACECRAFT (UHF)



NOTES:

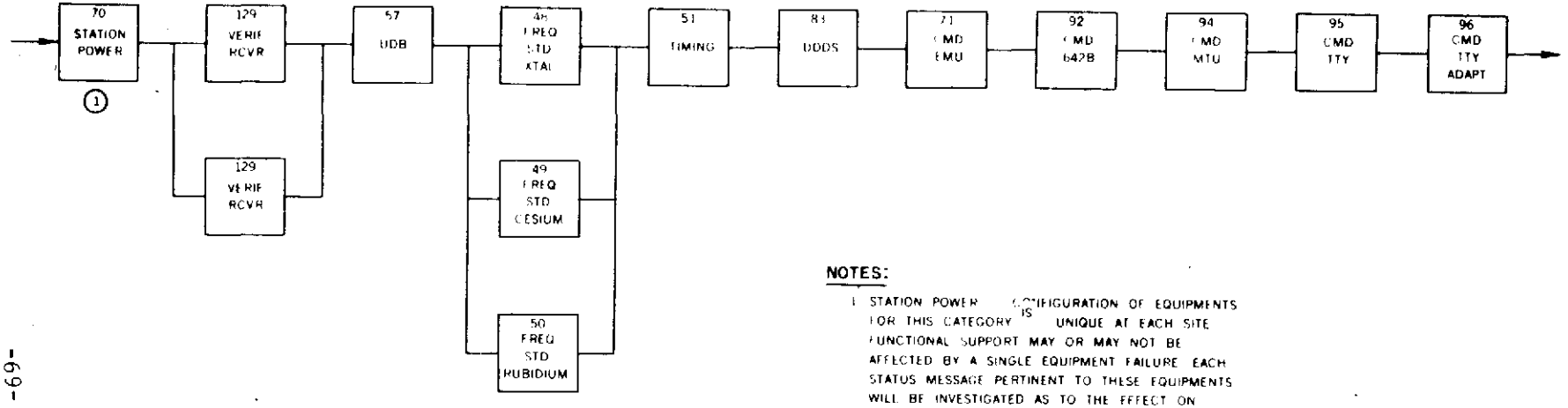
1 STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

AA –30′ ANTENNA DUAL

AA AND BB –85′ ANTENNA PRIME AND DUAL

FIGURE 17A

Ⅳ–D VERIFY COMMANDS ARE SENT (USB)

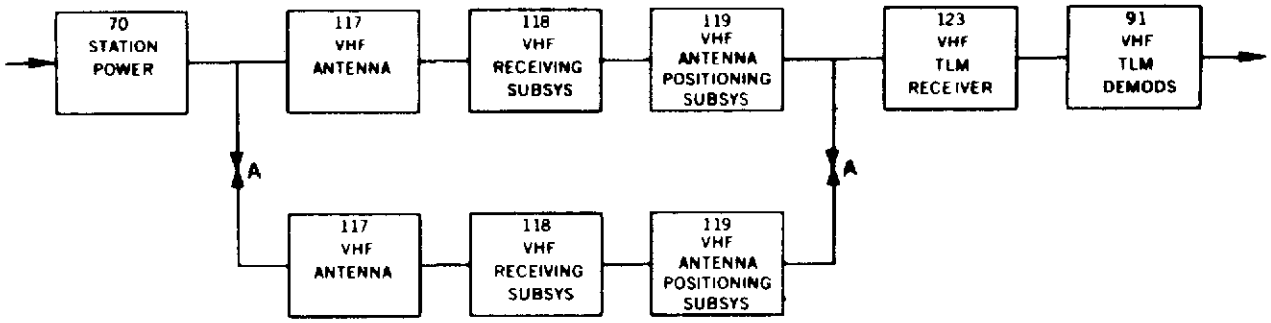


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE 17B

IV-D VERIFY COMMANDS ARE SENT (UHF)

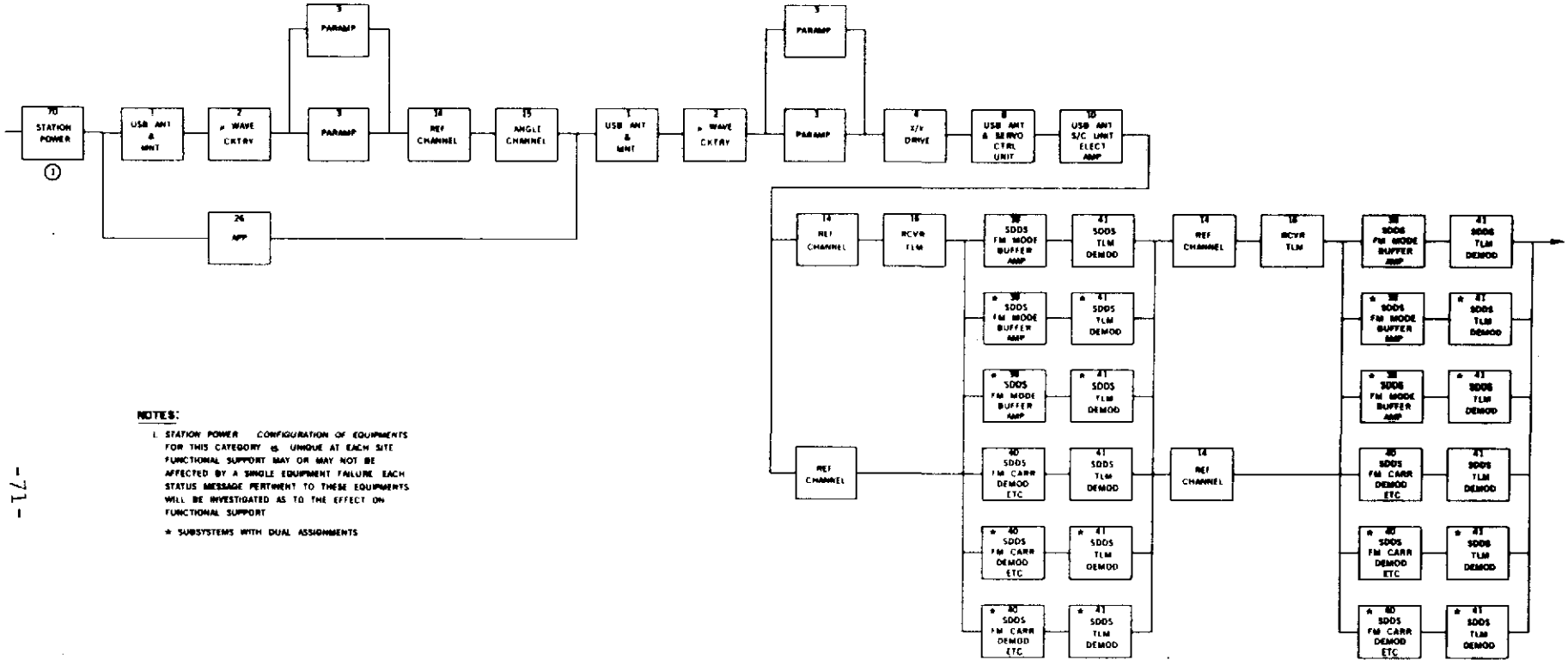


NOTES:

1. TWO TYPES OF SITES (SINGLE VHF AND DUAL VHF) ARE REPRESENTED BY THE DIAGRAM.
2. A SINGLE TYPE SITE IS REPRESENTED BY THE DIAGRAM LESS A EQUIPMENT BLOCKS.
3. A DUAL TYPE SITE IS REPRESENTED BY ALL THE EQUIPMENTS IN THE DIAGRAM.
4. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 18A

IV-E VERIFY COMMANDS ARE RECEIVED (UHF CMD)



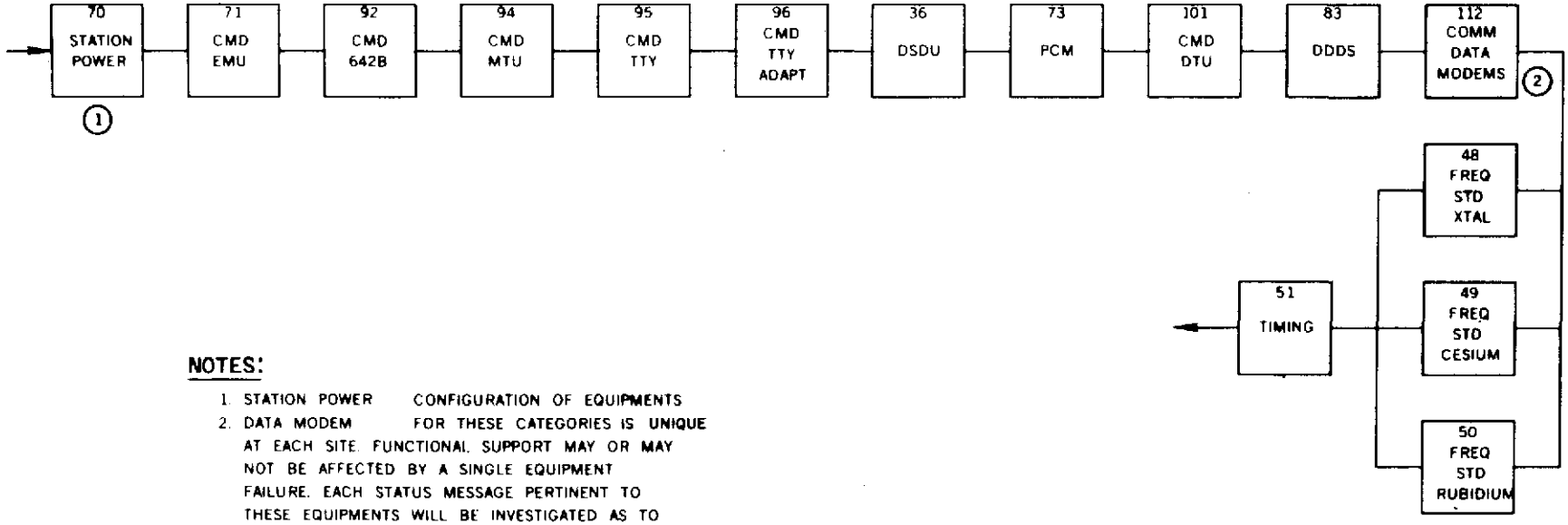
NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

* SUBSYSTEMS WITH DUAL ASSIGNMENTS

FIGURE: 18B

IV-E VERIFY CMD'S ARE RECEIVED (USB)

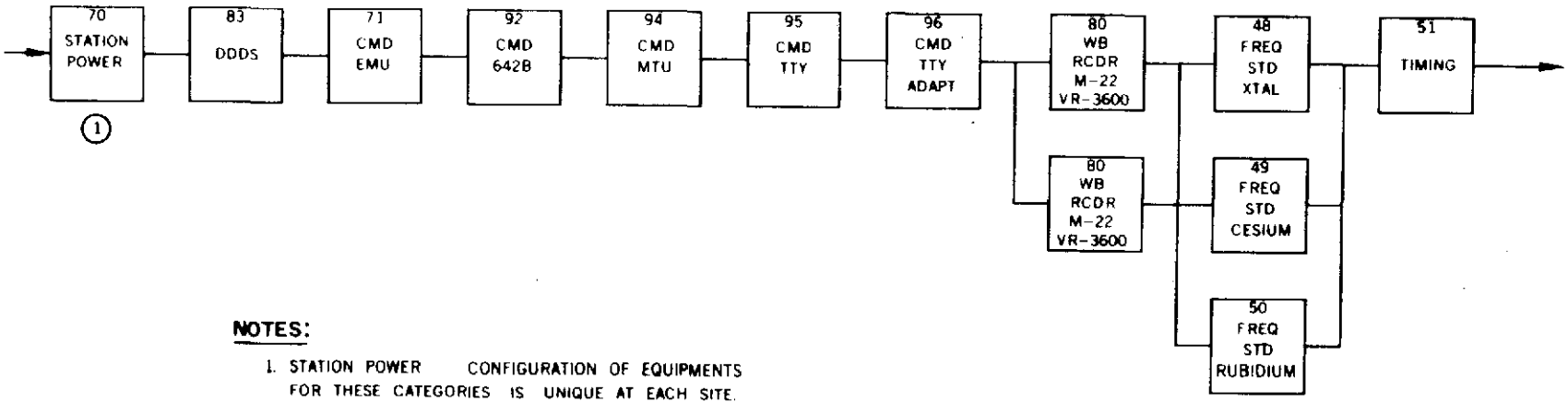


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS
2. DATA MODEM FOR THESE CATEGORIES IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

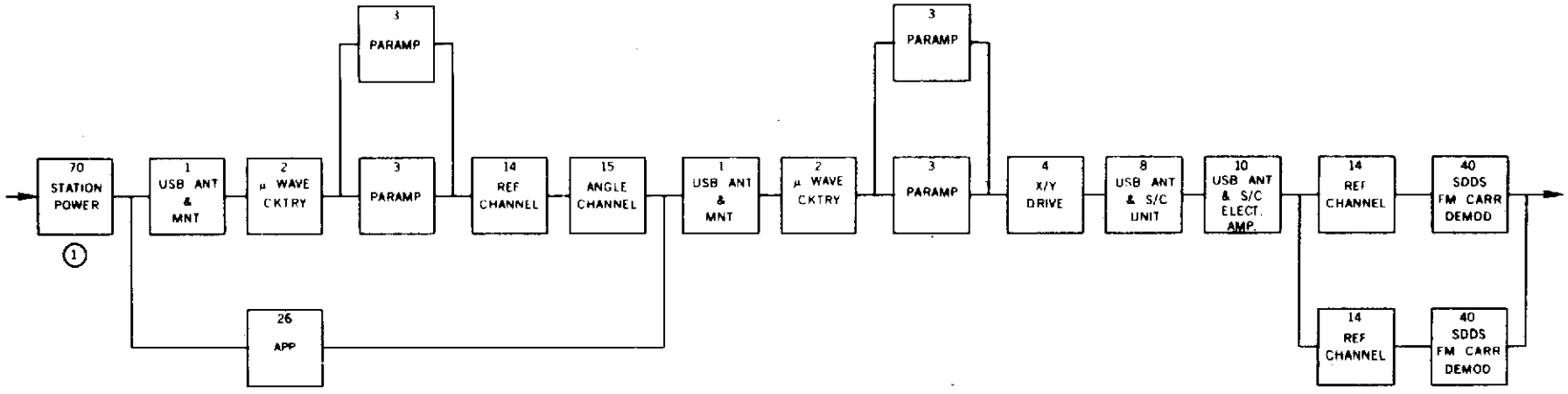
FIGURE: 19

IV-F TRANSMIT COMMANDS TO MCC



NOTES:

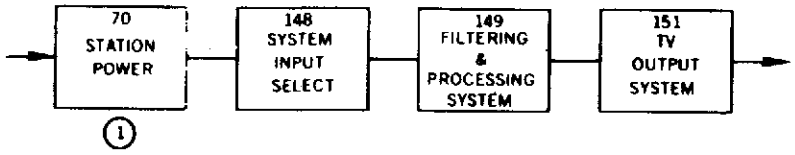
1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THESE CATEGORIES IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.



NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILLLBE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT

FIGURE 2:

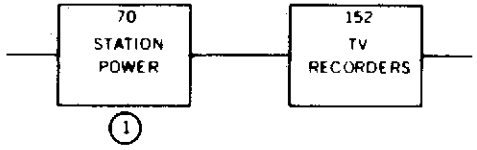


NOTES:

1. STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE. FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 32

V-E PROCESS AND TRANSMIT TV TO USER



NOTES:

1 STATION POWER CONFIGURATION OF EQUIPMENTS FOR THIS CATEGORY IS UNIQUE AT EACH SITE FUNCTIONAL SUPPORT MAY OR MAY NOT BE AFFECTED BY A SINGLE EQUIPMENT FAILURE. EACH STATUS MESSAGE PERTINENT TO THESE EQUIPMENTS WILL BE INVESTIGATED AS TO THE EFFECT ON FUNCTIONAL SUPPORT.

FIGURE 23

V-C RECORD TV ON SITE